L. S. Joynes

PRINCIPLES OF MEDICINE:

COMPRISING

GENERAL PATHOLOGY AND THERAPEUTICS,

AND A BRIEF GENERAL VIEW OF

ETIOLOGY, NOSOLOGY, SEMEIOLOGY, DIAGNOSIS, PROGNOSIS, AND HYGIENICS.

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TO THE

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This Volume

IS INSCRIBED,

BY THEIR

FAITHFUL AND OBLIGED FRIEND AND LATE PRESIDENT,

THE AUTHOR.

PREFACE OF THE AMERICAN EDITOR.

In the preface of the first American edition, it was remarked that "a work on General Pathology supplies a want in English medical literature." The rapid sale of three large editions of the "Principles of Medicine," and the great favor with which it has been received by the profession, confirm this opinion. It possesses the strongest claims to the attention of the medical student and practitioner, from the admirable manner in which the various inquiries in the different branches of pathology are investigated, combined, and generalized by an experienced practical physician, and directly applied to the investigation and treatment of disease.

The publication of Professor Chomel's classical *Elémens de Pathologie Générale*, translated by Drs. F. E. Oliver, and W. W. Morland, of Boston, and of Dr. Stillé's "General Pathology," since that time —both valuable accessions to our literature—has not superseded the necessity of the present work. From their more limited plan, they treat chiefly of Etiology, Nosology, Semeiology, Diagnosis and Prognosis; whilst the Nature and Constitution of Disease—the chief subject-matter of the following pages—is scarcely touched upon. The scope of a work on General Pathology has been thus correctly defined: "The legitimate object of a work on General Pathology is the study of diseases in the abstract, and in that which they have in common. It should serve as a complement to special and descriptive pathology, just as general anatomy does to descriptive anatomy. It should comprise all that is most simple and most elevated in science; on the one hand, the definition of the terms, and the description of the phenomena of diseases; on the other hand, the discussion of all the fundamental questions, and the exposition of the general principles which should serve to guide the physician in the arduous exercise of a profession so intimately connected with the dearest interests of humanity. General

Pathology, in fact, includes within itself the humblest elements, and the most sublime philosophy of medicine."[1]

The chief additions by the editor will be found in the sections on Etiology, Diseases of the Constituents of the Blood, Nutrition, Semeiology, Prognosis, and Hygienics. The section on Semeiology has been greatly enlarged, and an abstract of the general signs of disease added. The editor's matter is distinguished thus: [—C.] M. C.

Philadelphia, June, 1853.

[1] Medico-Chirurgical Review, 1843.

PREFACE.

More than a year has elapsed since the first edition of this work was out of print, and it has been the subject of continual regret on my part that my engagements have so long retarded the completion of the present. Some excuse for the delay will, I trust, be found in the very extensive additions which it contains, comprising the enunciation and application of most of the facts and established deductions made available to the science and art of medicine during the last few years. These additions pervade almost every portion of the work; but they preponderate in the following subjects:—

In Etiology, *mechanical*, *chemical*, and *dietetic causes of disease*, *defective cleanliness*, *ventilation*, and *drainage*. In Pathology, the tabular views of the elements of disease; *reflex action and sympathy; elementary changes in the blood; congestion; determination of blood; inflammation*, in its nature, manifold results, and modes of treatment; *degeneration of textures; cacoplastic and aplastic deposits*, and their treatment, with a notice of the action of the *cod-liver oil;* and the whole chapter on *Hygienics*, comprising *food*, *clothing*, *air and temperature*, *exercise*, *mental occupation*, *sleep*, and *excretion*.

In endeavoring to adapt the work to the rapid improvements in medical science, it is most satisfactory to be able to state that in very few instances has it been necessary to retract or supersede the inferences and views set forth in the first edition; on many subjects they have been confirmed and extended by recent researches to a degree that has not less surprised than convinced me of their truth; as examples, I would mention the subjects *Congestion*, *Dropsy*, *Determination of Blood*, *Inflammation*, and *Deposits*. I am quite aware that my views on some of these subjects are opposed to those held by several distinguished and estimable pathologists; and the knowledge of this fact has led me to test them the more severely by all the experiments which physiology, clinical observation, and pathological research could supply; and the

result of this scrutiny, in which I have been aided by several able friends and pupils, has been a firmer and clearer conviction of their substantial truth. I would farther add, in favor of the views put forth on the above-named subjects, that they, as it were spontaneously, point to remedial measures closely corresponding with those which the best experience has sanctioned, and they simplify and facilitate the indications of treatment in a manner that suggests more efficient modes of practice than could be obtained by blind experience.

It is in harmony with the statement just made, that whilst I feel grateful for the approbation with which this work has been honored by scientific men, both in this and in foreign countries, I am especially gratified by the favor with which it has been received by practitioners of great experience. This favorable reception, as well as the assistance which it has afforded me in my systematic course of lectures on practical medicine, leads me to believe that my attempts to combine science with art, to place the practice of physic on a more rational basis, have not been altogether unsuccessful, and encourages me to hope that the present work may farther contribute to the same desirable end.

I am fully aware of the existence of many defects in the accomplishment of this work, some of which might be amended by delaying its publication a little longer; but the objections to such delay outweigh the probable advantages; and I must trust to the leniency of my critics to excuse the errors of omission and commission, which it is very difficult to exclude in a volume that is at once elementary and yet embraces a most extensive range of subjects.

7, *Holles Street, Cavendish Square,*
Feb. 19, 1848.

PREFACE

TO THE FIRST EDITION.

As an apology for the appearance of this publication, it may, I think, be stated to be generally acknowledged, that there is at present, no work which fully treats of the subject of General Pathology, and its application to practical medicine. The present attempt to supply the defect arose from my feeling the want of an elementary work on these subjects, by aid of which I could introduce to my pupils the science of practical medicine. With many excellent and elaborate treatises on the details of medicine, we have scarcely any which treat of those general principles in the nature and treatment of disease, which are really fundamental in the practice of medicine. Even the very able work of my distinguished friend, Prof. Alison (to which the following pages owe much), in the last edition, instead of some of these general principles, embraces some of these details of Special Pathology.

It may be supposed, that in subjects comparatively so modern as those embraced in this work, little reference can be made to any but recent authors; and for a great portion of the facts and illustrations, I have drawn on my own experience in the continual observation of disease, during upwards of twenty years, in hospitals and private practice. Throughout this experience, I have always endeavored to keep in mind the bearings of physiology and pathology on practical medicine, and to render their advances useful, by their application to this art. Many original facts and opinions have been the result of this mode of study; and some of these will be found in the following pages. I cannot expect that they will speedily receive a general assent; but I ask for them the test of clinical observation, from which they have been mainly derived.

It seems quite extraordinary that, notwithstanding the recent rapid improvements and comparative perfections of the contributory sciences,

practical medicine should still halt in the domain of empiricism. A chief reason for the anomaly seems to be, that science and practice have been rarely pursued by the same parties. Scientific men are not and cannot be practical, because they have had no experience; and practitioners know little of science, and therefore derive little good from it. Instead of working together, these parties are at issue with each other. But it is high time to put an end to this feud. Philosophers must descend from their transcendental positions, to consider details of practice and purposes of utility. Those who would be practitioners, must gain from science that knowledge and that method which render experience instructive and useful.

In the present effort towards the accomplishment of these objects, I am conscious of many deficiencies. Want of time has prevented me from treating some subjects as fully as they deserve, particularly those of the last chapter. In others, I have studied to be brief, to avoid perplexing the reader with much discussion or detail. For this reason, doubtful facts and a variety of conflicting opinions have been withheld; and only the facts best ascertained and the views which seem most tenable have been given. By this eclectic method, I have succeeded in reducing a very extensive range of subjects within the compass of a moderate volume.

7, *Holles Street, Cavendish Square,*
Sept. 22, 1843.

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PRINCIPLES OF MEDICINE.

EXPLANATION OF THE SUBJECTS OF THE WORK.

1. The Principles, Elements, or Institutes of Medicine comprise those leading and general facts and doctrines regarding disease and its treatment, which are applicable, not to individual cases only, but to groups or classes of diseases. The same branch of medical knowledge is also designated by the term General Pathology and Therapeutics, to distinguish it from special pathology and therapeutics, or the theory and practice of medicine in relation to individual diseases.

2. The principles of medicine may be deduced in part from a knowledge of animal structure and function (anatomy and physiology), conjoined with an acquaintance with the agents which cause and remove disease; but chiefly they are derived from a generalization of facts observed in an extensive study of disease itself, and its effects, in the living and in the dead body. But so far as they have been ascertained, they become more intelligible to the student if explained synthetically, by describing first the causes of disease, then their operation on the body, and lastly, the resulting changes in function or structure which constitute disease in its more elementary forms.

3. Etiology, or a knowledge of the causes of disease, will introduce us to their effect—*disease* itself; the nature and constitution of which will then be considered under the head of pathogeny, or pathology proper. As this last subject is the chief one to be treated, it will occupy the greater part of the work, and it will be combined with such an elementary view of the principles of treatment (general therapeutics), as reason and experience may supply.

4. A short general view will afterwards be given of the phenomena of disease (semeiology), the division and classification of disease (nosology), their distinction (diagnosis), their result (prognosis), and their prevention (prophylaxis and hygienics).

DEFINITION OF DISEASE.

5. The reader is supposed to be acquainted with anatomy and physiology; without a knowledge of these, we cannot proceed even to a defi-

nition of disease. Disease is known only by comparing it with the standard of health, which it is the object of anatomy and physiology to describe.

Health consists in a natural and proper condition and proportion in the functions and structures of the several parts of which the body is composed. From physiology, we learn that these functions and structures have to each other and to external agents certain relations, which are most conducive to their well-being and permanency; these constitute the condition of health. But the same knowledge also implies that function and structure may be in states not conducive to their permanency and well-being; states which disturb the due balance between the several properties or parts of the animal frame; and these states are those of *disease*. For example, physiology, as well as experience, teaches us, that in health the digestion of food is easy and comfortable. But when, after food is taken, there are pain, uneasiness, sickness, eructation, flatulence, or the like, we know that the *function* of digestion is changed from the healthy standard—is *diseased;* and if this diseased function continue long in spite of remedies which usually correct it, and if on examining the abdomen, we find at or near the epigastrium a hard tumor, which anatomy teaches us is not there in health, we know that there is also *diseased structure.*

6. We find, then (§ 5), that there is *disease of function*, known by its deviation from a standard furnished by *physiology;* and *disease of structure*, which we recognize by a standard supplied by *anatomy* (§ 5). These varieties of disease may be, and very commonly are, combined: there is seldom structural disease without some disorder of function; and in many instances functional disease is, or will be, accompanied by change of structure.

7. Looking, then, to anatomy and physiology as standards, we may define *disease* to be, *a changed condition or proportion of function or structure in one or more parts of the body.*

8. The standard of health is not, however, the same in all individuals; that which is health to one may be disease to another. Thus, if we instance individual functions: The healthy pulse in adults averages from 70 to 80; yet there are some in whom 90 or 100 is a healthy pulse. Some persons fatten on a quantity of food on which others would starve. The animal functions, muscular strength and activity, nervous sensibility, and the sensorial powers, vary still more in different individuals, yet all within the limits of health; and, what is health in one, would be decidedly morbid in another. Such unusual proportions of certain structures or functions constitute varieties of temperament; and although they can scarcely be called morbid, yet they certainly give, as we shall afterwards see, a proclivity to disease. Thus a predominance of the functions of the nervous system, sensibility and excitability of the excito-motory nerves, constitutes the nervous temperament, which is compatible with perfect health, although it predisposes the individual to diseases of the nervous system. A preponderance of the nutritive functions renders a person stout and bulky, although in perfect health; but it carries with it a risk of exceeding the bounds of health, and of inducing plethora and obesity, which, as they interfere with the well-being and order of the

bodily functions, constitute disease. But short of these degrees which are morbid, the functions and structures of the body present, in healthy individuals, a considerable variety in energy and development.

[All variations from regularity in the actions performed by living beings, constitute the phenomena of disease. The investigation of these phenomena, and the reduction of them to general laws, expressive of their conditions, is the object of Pathology. Here, as in the kindred science of Physiology, the study of all the conditions is requisite; and hence we have to make ourselves acquainted, on the one hand, with the characters of all the external agents which can produce a deleterious effect upon the living body, whether their operation be mechanical, chemical, or vital, as well as the results of the suspension, partial or complete, of the conditions by which its healthy action is maintained. We have, too, to investigate the changes of structure which manifest themselves in the body itself, and the countless variety of secondary results which arise from any disturbance of its train of actions. The Pathologist sets out with endeavoring to determine the individual phenomena of diseased action, and when he has collected these in sufficient amount to serve as the basis of an induction, he attempts to ascertain the conditions common to all, and hence to arrive at their laws. The general principles of Pathology can only be founded on a knowledge of the elementary phenomena of disease. The *ars medendi*, or the practice of the healing art, is based on the *ratio medendi*, or its theory. Were the science of Pathology more perfect, the rules deduced from its general principles would be of easier application, and would require only correct observation of the circumstances which called for their employment.—C.]

CHAPTER I.

ETIOLOGY.—ON THE CAUSES OF DISEASE.

SECTION I.

NATURE AND DIVISION OF CAUSES.

9. CAUSES of disease are those circumstances which essentially precede it, and to the operation of which its occurrence is due. In many instances, these circumstances elude our observation. In many others, the true cause, if apparent, is combined with other antecedent circumstances which have no share in producing the disease, and yet are liable to be mistaken for causes. These circumstances are to be sifted and the true cause discovered, only by the attentive observation of large numbers of cases, in which disease is produced. The non-essential circumstances will then be found to be sometimes absent, and that which is always present may be fairly regarded as the cause. But this, as before stated, sometimes eludes observation; and both in this case and in elucidating the operation of circumstances supposed to act as causes, the most useful knowledge may be obtained from an investigation of the ultimate nature of disease itself, which will often throw light on the cause which has induced it. Thus, it was long a matter of doubt whether the itch could be engendered from filth, as well as from contagion; but since microscopic investigation has discovered the existence of the itch-mite, no doubt remains that this insect is the only essential cause of the disease.

10. The causes or circumstances inducing disease may be *intrinsic*, or existing within the body, independently of any obvious external influence; or they may be *extrinsic*, having their origin without the body. As examples of intrinsic causes may be mentioned excess or defect of some function, as irritability, or of some constituent of the body, as the blood. Extrinsic causes are very numerous; comprising all the external agencies which can operate on the body or mind, such as temperature, air, moisture, food, poisons, mechanical and chemical influences, sensual impressions, &c. &c.

11. A great variety of agents and circumstances may thus act on the body so as to produce disease; but, in most instances, there is not that uniform and constant relation between these as causes, and the diseases

as effects, which we might expect from the analogy of causation in the simpler sciences. In chemistry or in mechanics, effects certainly and uniformly follow causes; in physiology or pathology, no doubt, effects also ensue; but whether these effects shall be manifest as disease or not, will depend on many circumstances, of which we often cannot take cognizance. It is true that when the causes resemble and act like those of physics or chemistry, their proper effects will not fail to ensue. Thus, a cutting instrument, a redhot iron, or a corrosive liquid, will not fail to produce disease, because its operation is so energetic as to overcome all vital properties by physical and chemical force, and disorder must follow. Further, certain poisons and other potent agents, which act on without destroying the vital properties of living parts, may also, if of sufficient strength, pretty constantly produce morbid effects. Thus, opium, taken internally, causes somnolency; tartar emetic excites nausea and vomiting; cantharides applied to the surface induces inflammation, &c.

12. But the common causes of disease are seldom of this decided and positive character; they are often present without disease ensuing; and they are known to be causes only because disease is observed to ensue in a greater number of cases when they are present than when they are absent. Thus, improper food is a cause of indigestion, and exposure to cold is a cause of catarrh; yet many persons eat unwholesome food without suffering from indigestion, and many are exposed to cold without "taking cold." But those who *do* suffer from indigestion observe that they do so more after taking improper food; and those who *are* affected with catarrh can often trace it to exposure to cold. The reason of this uncertainty of action is chiefly in various powers by which the body resists the morbific influence; which powers vary much under different circumstances. The failure or irregular operation of this power constitutes one predisposition to disease.

13. Causes of disease were formerly divided into *remote* and *proximate;* the remote include both the *predisposing* and the *exciting* causes, the only circumstances now considered as causes. They were called *remote*, not because they are distant or not in the body, but because they are not, like the proximate cause, a constant and present part of the disease. The term *proximate* cause, was used by Cullen (after Gaubius) to represent the pathological condition, or essential bodily change, on which the symptoms depend; and it was called a *cause* of *the disease*, because diseases were by him defined to be an assemblage of symptoms. But this essential bodily change is rather a part of the disease than a cause, and must be considered under the head of *pathology*. Discarding, then, the term proximate cause, we have only to consider the *predisponent* and *exciting* causes.

14. The co-operation of both these kinds of causes is generally necessary to produce disease. A number of persons are exposed to cold: one gets a sore throat; another, a pleurisy; another, a diarrhœa; another, some form of rheumatism; and a fifth escapes without any disease. All five were exposed to the same cause, yet it acted differently on all. The first four were *predisposed* to the disease, which attacked them as soon as it was *excited* by the cold. The fifth had no predisposition; the

exciting cause was therefore powerless; it was insufficient without the predisposing cause; as in the other cases, the predisposition was insufficient until the exciting cause, the cold, was applied.

15. In some cases, however, where sufficiently strong, what is in a smaller degree a predisposition, in a greater degree constitutes a sole cause of disease (§ 11); thus a person with a very weak stomach always has indigestion, whether an exciting cause be applied or not. So likewise exciting causes, if sufficiently strong, may produce disease without predisposition; thus a person not predisposed to indigestion may be pretty sure to earn it, if he take a sufficient quantity of fat, raw cucumber, pickled salmon, or any such indigestible matter. Take another example. A healthy person living in a marshy district may not get an ague, until he becomes debilitated by any cause, such as cold, or fatigue; then the poison will act. But without his being thus weakened, if the exciting cause be made stronger by his sleeping on the very marshy ground itself, then the poison may act without predisposition, and the ague begins (§ 12).

16. The consideration of these facts throws some light on the nature of many predisponent causes. There is, in organized beings, a certain conservative power which opposes the operation of noxious agents, and labors to expel them when they are introduced. The existence of this power has long been recognized, and in former days it was impersonated. It was the *archæus* of Van Helmont; the *anima* of Stahl; the *vis medicatrix naturæ* of Cullen. But without supposing it to be aught distinct from the ordinary attributes of living matter, we see its frequent operation in the common performance of excretion; in the careful manner in which the noxious products of the body, and offending substances in food, are ejected from the system; in the flow of tears to wash a grain of dust from the eye; in the act of sneezing and coughing to discharge irritating matters from the air-passages; and in the slower, more complicated, but not less obvious example of inflammation, effusion of lymph, and suppuration, by which a thorn or other extraneous object is removed from the flesh.

17. This *vis conservatrix* (§ 16) is alive to the exciting causes of disease; and in persons in full health, it is generally competent to resist them. How it resists them will depend on what they are. For instance: Is cold the cause? This throws the blood inwardly; which, by increasing the internal secretions, and exciting the heart to increased action, establishes a calorific process, which removes the cold. Is the cause improper food? The preserving power operates by discharging this speedily by vomiting or by stool. Is it a malarious or contagious poison? It is carried off by an increase of some of the secretions. But if this resisting power (§ 16) be weakened, locally or generally, or if the exciting cause be too strong for it, then the cause acts, and disease begins (§ 15).

18. In the cases hitherto noticed, predisponent causes consist in absence or deficiency of power (§ 16), rather than the existence of anything positive; but sometimes predispositions depend on something positively wrong in function or structure, which alone may scarcely

amount to disease; and this error may be congenital, or hereditary, or acquired from previous disease.

19. It must be observed that predisponent causes operate chiefly through the constitution, or some of its powers; hence they are often called *constitutional* or *internal* causes, in contradistinction to the exciting causes, which are more commonly *external*. But these terms are objectionable, because not always applicable. Sometimes the term *predisposing* is also inappropriate, as in the following instance: Several persons are exposed to a malarious or infectious poison; some of these afterwards suffer much from fatigue or privation; they then begin to show the effects of the poison; others, who have not suffered this second trial, escape unhurt. The poison has entered the system of both; the last resist its influence; the subsequent weakening reduces the powers of resistance in the first class, and exposes the system to the exciting cause; but, occurring after, it cannot be said to *predispose*. Hence, under such circumstances, the fatigue or privation is called the *determining* cause.

The frequent inapplicability of the terms under which the causes of disease are classified, suggests the truth that these divisions of causes are rather conventional and convenient, than natural and philosophical. The true, simple view of causes, is that they are circumstances inducing disease. If strong, one such may be sufficient; if weak, two, three, or more may be required to operate together, or in succession, before that change of function or structure, which constitutes disease (§ 8), ensues. Which of these several circumstances respectively disposes, excites, or determines, and would therefore come under the divisions that I have endeavored to explain, will often be very difficult to decide.

SECTION II.

PREDISPOSING CAUSES OF DISEASE.

20. Predisposing causes of disease commonly consist of various circumstances which influence the functions or structures of the body in an unfavorable manner, yet short of actual disease. It will be useful to illustrate them by examples, which I will group under the following heads.

I. Debilitating Influences.
II. Excitement.
III. Previous Disease.
IV. Present Disease.
V. Hereditary Constitution.
VI. Temperament.
VII. Age.
VIII. Sex.
IX. Occupation.

I. Debilitating Causes of Predisposition are the most numerous

of any. So we might expect, from the fact that constitutional strength generally implies power of resisting disease (§§ 16, 17). The weakness which renders the body liable to disease is that especially which enfeebles the heart, and impairs the tone of the arteries; it is often accompanied with an unusual susceptibility of the nervous system, which increases the liability of the body to suffer. The following are the chief of this class.

21 (*a*). *Imperfect nourishment*, from defect either in the quantity or quality of the food, or from incapacity of the digestive powers. This in itself may cause many diseases, particularly of digestion and nutrition; but it also weakens the power to resist cold, and produces a liability to low fevers and inflammations, epidemic and contagious disorders. Thus the susceptibility of the body to cold and to infection, when fasting, is generally acknowledged; and the rapid propagation of infectious diseases among an ill-fed population, such as the poor Irish, is too well known.

22 (*b*). *Impure air*.—The injurious effects of this are apparent in the pallid, cachectic complexion of the inhabitants of crowded cities, even those who live well and regularly. How do they contrast with the ruddy countenances of the hardy and coarsely-fed mountaineer! So do they also in their liability to diseases, particularly to those of the organs of respiration, circulation, and nutrition.

[One of the most fertile sources of infantile disease, is a want of a due supply of pure and wholesome air; the effects of which are sure to manifest themselves, though often obscurely, and at a remote period. It is physiologically impossible for human beings to grow up in a sound and healthy state of body and mind, in the midst of a close, ill-ventilated atmosphere. Those that are least able to resist its baneful influences, are carried off by the diseases of infancy and childhood; and those whose native vigor of constitution enables them to struggle through these, become the victims, in later years, of diseases which cut short their term of life, or deprive them of a large portion of that enjoyment which health alone can bring. This statement is supported by facts. A recent visitor to the Island of St. Kilda, the most northern of the Hebrides, states that eight out of every ten children, die between the eighth and twelfth day of their existence; in consequence of which terrible mortality the population of the island is diminishing, rather than increasing. This is due not to anything injurious or pernicious in the atmosphere of the island; for "its air is good and the water excellent; but to the filth in which the inhabitants live, and the noxious effluvia which pervade their houses." The huts are small, low-roofed, and without windows, and are used during winter as stores for the collection of manure, which is carefully laid out upon the floor, and trodden under foot, till it accumulates to the depth of several feet. The clergyman, who lives exactly as those around him do, except as regards the condition of his house, has reared a family of four children, all of whom are well and healthy; whereas, according to the average mortality around him, at least three out of four would have been dead within the first fortnight. At the end of the last century, in the Dublin Foundling Hospital, during a space of 21 years, ending 1796, out of

10,272 sick children, sent to the infirmary, only 45 recovered. Deficient ventilation, from the crowding of the wards, was an efficient agent in this fearful result.[1]—C.]

23 (*c*). *Excessive exertion of body or mind.*—Exercise is beneficial to both body and mind; but when in degree or continuance it exceeds what the strength can bear, or rest can recruit, the animal functions are exhausted, and lose their balance; muscular tone is impaired, nervous excitability takes the place of strength, the circulation fails, congestions ensue, the blood is not properly purified, and the various organs are on the brink of disease. It is thus that the fatigued mind or body is peculiarly prone to suffer from causes of disease. Want of sleep has similar effects; and when the body is extremely exhausted, even sleep, which is nature's best restorer, is disturbed by the imperfect performance of circulation and respiration in the excess of weakness; hence a liability to insomnia and nervous excitement from exhaustion.

24 (*d*). *Want of exercise and sedentary habits generally*, form another extreme which favors the production of disease. The healthy vigor of all the functions of the body and mind is best maintained by their equal and moderate exercise; and the torpor of inactivity renders them incapable of resisting the causes of disease. The muscular function, and with it the circulation of the blood, is the first to suffer; hence first sluggish movements, and ultimately weakness of the heart and other muscles. The defective circulation is felt most at parts at a distance from the heart, hence cold extremities, dry skin, congested liver, with its frequent concomitants, hemorrhoids, torpid bowels, and indigestion; whilst the heart itself and the organs near it may be oppressed and injured by the load of blood in them, especially if the subject is plethoric; hence palpitation, dyspnœa, headache, vertigo, somnolency, dulness of the senses, &c. &c. In nervous subjects, convulsive affections may be promoted by the same inequality of circulation. The respiration being little exercised, the task of decarbonizing the blood is imperfectly performed, or falls more on the liver; hence the accumulation of fat in the textures, and the occurrence of bilious derangements. From this statement it is obvious that sedentary habits, where extreme, may be equivalent to produce disease, and where existing in less degree, they promote its occurrence from other causes, such as irregularities of diet, exposure to cold, violent exertion, &c. From such combination of influences arise various disorders of the digestive organs, heart, lungs, and brain, catarrhs, gout, rheumatism, calculous affections, diseases of the skin, &c.

25 (*e*). *Long-continued heat.*—The debilitating effects of this agent are exemplified in warm climates and seasons. Under its influence, the muscles, and with them the heart and arteries, lose power and tone; the textures become relaxed; perspiration is profuse; and internal organs, especially the liver, are too much stimulated by blood which has lost more than usual of its water, and less of its hydro-carbon. Hence the disposition to bilious and liver complaints, dysentery and cholera. [The action of heat is debilitating from the losses the economy sustains

[1] Carpenter's Animal Physiology, pp. 3, 4.

from the undue cutaneous secretions, and from over-stimulation of the nervous system. This debilitating action of heat is increased when combined with moisture. Diseases of the gastro-intestinal mucous membranes are more especially developed. Under the influence of these two agents combined—heat and moisture—there is a marked tendency in diseases to assume a typhoid or adynamic form.—C.] Overheated rooms and excessive clothing likewise predispose to disease by their weakening and relaxing influence. [Warm clothing is a source of disease, and very often of the same diseases which originate in an exposure to cold. Overheated sitting and sleeping apartments, warm soft beds and bedclothing, relax and weaken the frame, disposing to disorders of the renal, urinary, and generative organs, and render the system generally much more impressible to external injurious influences. A predisposition is thus induced not only to catarrhs, inflammations, affections of the lungs, and rheumatism, but to irregularity in the menstrual discharge. It has been remarked that the females of Holland, who generally use very warm clothing, warm apartments, warm beds, and footstoves, are subject to excessive menstruation and leucorrhœa. —C.] It may be remarked that most of the diseases of hot climates and seasons occur rather at the termination of the heat than during its steady prevalence, and that therefore it predisposes to, rather than excites, the disease, which is the immediate effect of cold, or of irregularity of diet, or of malaria. Thus the bilious cholera of this country occurs chiefly in the early autumn, when the cool of the evening forms a contrast with the heat of the day. The chill suddenly arrests the perspiration, and throwing the blood inwardly, oppresses internal organs, especially the liver, whose vital energies have been exhausted by the influence of the previous heat; hence coldness of the surface, and congestion of the liver and portal system, ending in flux, cholera, diarrhœa, dysentery, &c.

26 (*f*). *Long-continued cold.*—The experiments of Chossat and others clearly prove cold to be a direct sedative, capable of reducing all the vital properties. Cold applied suddenly and for a short time, invigorates, because it is followed by a healthy reaction, in which the vital properties are exercised and exalted. But when long continued, its own sedative and debilitating effects are permanent; it weakens the circulation, especially that of the surface, causes internal congestions, and directly lowers all the vital energies. Hence the most malignant forms of epidemic fever in this country are observed to prevail towards the close of very severe winters; and all diseases may then assume a typhoid type. This is observed chiefly among the lower orders, whose means do not enable them to protect themselves sufficiently against the inclemencies of the season. We have before adverted to the striking manner in which cold disposes the body to suffer from malaria.

27 (*g*). *Habitual intemperance with intoxicating liquors.*—There is probably, in this country, no source of disease more fertile than this. Besides many which it excites, it predisposes the body to attacks of fever, erysipelas, dysentery, cholera, dropsy, rheumatic and urinary diseases; and if it do not increase the proneness to inflammatory disorders, the habit of intemperance certainly disposes them to unfavor-

able terminations, and causes many a victim to sink after accidents and operations, which would be comparatively trifling in a sober subject. Nor can we wonder at the pernicious effects of this kind of excess, when we consider the weakened state of function and structure which stimulating drinks induce, especially in the organs which they most directly affect—the stomach, the liver, the kidneys, the heart, and the brain. We shall soon have to explain how such an unsound state of these organs peculiarly impairs the powers of the body to resist or throw off disease (§ 17).

28 (*h*). *Depressing passions of the mind, such as fear, grief, and despondency.*—Many are the instances in which numbers, as well as individuals, have escaped a prevalent disease, until depressed by some unhappy event or apprehension, and then they have fallen victims. Such was instanced in the ill-fated Walcheren expedition, and in many passages in the history of armies in pestilential countries. A defeat, a failure, or even bad news, made many succumb to the pestilence who had before escaped. It is a common remark, that when a contagious or epidemic disease prevails, those who take most precautions frequently suffer, because they are timid and fearful, whilst the stout-hearted and reckless are unscathed. [When the mental energies are depressed by fear, grief, anxiety, disappointment, &c., the powers of life are less able to oppose the debilitating causes of disease; and individuals, singly, or collectively, are, under such circumstances, especially liable to those disorders which are of a general or specific origin, as fevers, &c. There is nothing which more certainly predisposes the system to the operation of the exciting causes of fever, than the fear of being attacked by it. On the contrary, when the mind is elevated by success, hope, and confidence, or other exciting passions, depressing causes make little or no impression upon the constitution, and individuals thus circumstanced almost always escape from diseases which readily invade the fearful, the dejected, and the disappointed. Indulgence of temper and passion not only predispose to disease, but frequently excite it, in the nervous, irritable, and sanguine temperament. Diseases of the heart, brain, liver, stomach, and bowels often originate in these sources. Uncontrolled passions of every description occasion a host of functional and structural disorders of the great viscera, whilst moderation of all the appetites, an equable state of mind, and the moderate excitement accompanying a well-regulated application to business or study, are among the best means of resisting the impression of injurious agents.—C.]

29 (*i*). *Excessive and repeated evacuations, either of the blood or of some secretion.*—The weakening effect of a large loss of blood needs no explanation; but the injurious influence of habitual losses or drains, if there be more than the system can repair, is still greater; for the functions then become depraved as well as depressed, a state of cachexia as well as anæmia is induced, and a little cause may suffice to determine many states of disease. Various hemorrhages and discharges, menorrhagia, diarrhœa, leucorrhœa, and other fluxes, if in excess, reduce the powers of life and the capacity to resist disease. No secretion, however, weakens so much or so irreparably, when in excess, as that of semen. In many of the lower tribes of animals, the males live till they

copulate, and then die; the reproduction of the species is at the expense of the individual. That our species is not wholly exempt from this law of organized nature, is apparent from the fact that immoderate venery is known to produce extreme debility and premature decay, and to dispose the body and mind to various diseases. [Excessive sexual indulgence is a frequent predisposing cause of many diseases. Pulmonary and cardiac disorders, epilepsy, mania, and other disordered manifestations of mind, not unfrequently occur, from the condition of the system induced by the abuse of this appetite. It also leads to other maladies by depressing the vital energies of the frame, and rendering it more assailable to the common exciting causes of disease.—C.]

30 (*j*). *Previous debilitating diseases.*—It is well known that the body is unusually liable to disorder during convalescence from serious maladies. It is weak in all its powers; whilst the nervous system often obtaining the ascendency which is common in states of weakness, renders the body unusually susceptible (§ 23); and improper food, exertion, excitement, or exposure to cold, may readily produce the former or some new complaint. Hence convalescence from a severe disease is a condition of health that requires peculiar care. The functions are just resuming their balance, and have neither the vigor of action, nor the power of resistance which is the attribute of robust health. The diseases which leave the body most liable to derangement are those ending in exhaustion, as continued fevers and protracted and severe inflammations.

31. II. Hitherto we have considered only those circumstances which predispose to disease by their weakening influences (§§ 16, 17, 20). There are others, of a somewhat opposite character, which favor the production of disease by a STATE OF EXCITEMENT OR ACTIVITY. Thus full living, without an adequate amount of exercise, may bring the circulation and other functions up to a high-pressure degree of activity without producing disease; in fact, there is a redundancy of health; and there is more than usual capability of resisting those causes of disease which operate by depression, such as cold, malaria, infection, &c. But there is a predisposition to suffer from causes of additional excitement; thus irritants applied, more readily induce inflammation; violent exertion may cause hemorrhages; and in any organ the operation of a stimulus may heighten the actions to a pitch that is morbid (§§ 5–8). So, also, unusual vascular activity in a part, when insufficient to produce disease, renders the part more liable to suffer from external causes. Thus the determination of blood to the uterus and mammæ at certain periods, renders them liable to disease at those times. Violent exertion makes the muscles or their fasciæ peculiarly liable to rheumatic inflammation from the subsequent action of cold and damp. Excessive indulgence in a stimulant diuretic beverage, such as punch, renders the kidneys liable to inflammation or congestion on exposure to cold. Inflammation or irritation of the intestines is not a common effect of cold, except when these viscera are under the exciting influence of a purgative. The brain, if previously over-active from hard study, may be excited into inflammation by alcoholic stimulus or strong moral emotion.

32. III. Proclivity to disease is not unfrequently caused by PREVIOUS

DISEASE, independently of the weakening influence before noticed (§ 30). This is particularly the case with some inflammatory and nervous disorders. Thus, a child who has once had croup is very liable to its recurrence. One attack of enteritis frequently predisposes to its recurrence. Convulsive disorders, such as chorea, hysteria, and epilepsy, are extremely apt to recur; and the longer they have existed, the more difficult are they to remove, and the more ready are they to reappear on the application of any exciting cause. This is what may be called a habit of disease, which is most important to prevent. There can be little doubt that the previous attack in all such cases leaves some change of structure or function (§ 18), which constitutes the predisposition, although this change may elude our means of detection.

33. Under this head we may arrange many constitutional predispositions to disease which are to be ascribed, not to a previous attack, but to the persistence in the system of a cause of that attack. Rheumatism, gout, gravel, many cutaneous diseases, dropsy, jaundice, and many others, may be quoted as examples. A person who has once suffered from any of these is very liable to a recurrence on the application of an exciting cause; and this is because, although free from the first attack, he may not be free from some functional or structural imperfection (§ 18) which was the predisponent to that attack, and which may again be brought into operation by the addition of an exciting cause. In most of these cases, the constitutional defect is in some of the processes of assimilation or excretion, this defect being generally functional, but in some cases it is also attended with change of structure, especially in the great eliminating organs, the liver and the kidneys. When the tendency to the diseases under notice is acquired, it may be often traced to causes which peculiarly affect these organs, such as intemperance or irregularities of diet, sedentary habits, and scarlet fever.

Nor can we separate from this class of constitutional causes (§ 32) the predispositions to many structural diseases, such as tuberculous and malignant formations. Where such have once appeared, there is a tendency to the production of more, although this tendency may be latent until brought into activity by an exciting cause. In the following pages many arguments will be found in favor of the view that the disposition to these diseases is connected with errors in the functions of assimilation and excretion.

34. IV. DISEASE ALREADY EXISTING IN THE BODY, even when itself latent, often predisposes to other disorders, independently of its weakening effect (§ 20). Thus, tubercles and other tumors, structural lesions of the heart and other organs, often induce irritations or obstructions of bloodvessels, which, if not themselves causing open disease, render them ripe for disorder from other causes. Thus, a person on the occasion of violent bodily or vocal exertion, is seized with profuse spitting of blood, which causes his death; on opening the body many tubercles are found in the lungs, although there had been no obvious symptoms of their existence before the violent effort. Again, disease of the heart, causing accumulation in the veins, often leads to congestion of the lungs and liver; and it may only require the addition of an exciting

cause, such as sudden exertion, or an excess in diet, to bring about an attack of asthma or jaundice. These are mere instances of causes coming into operation by accumulation. Granular disease of the kidneys, which impairs their excreting power, renders the body more liable to suffer from infectious and other poisons, and from other exciting causes of disease.

35. The predisposing causes hitherto considered, may be called accidental or acquired. There are others which are born with the individual; and others which arise from circumstances of age or growth. All these may be supposed to depend on something defective or ill-balanced in the organization (§ 18), which is insufficient to manifest itself until wrought upon by an external exciting cause.

36. V. Of the predispositions born with the individual, the most generally acknowledged, is HEREDITARY TENDENCY TO DISEASE. It is well known that scrofula, gout, rheumatism, epilepsy, mania, asthma, blindness, and deafness, run in families. That this depends on individual peculiarities transmitted from parents to offspring, appears from the fact that all children do not partake, or not alike, of the disposition. [Thus it has been observed that in constitutional syphilis, a first child, born of parents, one of whom has been infected, may be tainted with the venereal poison, whilst the second would be perfectly healthy, a third would be diseased, and a fourth sound; thus alternating, as it were. Children born of gouty parents have escaped entirely the disease, but have transmitted it to their offspring, who have suffered from well-marked fits of podagra.—C.] Nay, sometimes a whole generation is passed over, and the disease appears in a third. So, too, we see external organization, family likeness, differently stamped on different children of the same family. [The influence of hereditary transmission is proved by numerous and positive facts; indeed, peculiarities of configuration or feature are not more decidedly transmitted from the parent to the offspring, than constitutional taint, and certain pathological conditions. It is not simply the influence of temperament, which, endowed with the same peculiarities, tends to produce the same disease, but a settled, inherent disposition to such, or such pathological development, which may be found, even when the resemblance does not exist. Under this influence, the disorder may go on, being propagated from one generation to another, or it may stop short at one. But in the latter instance, it seems necessary that this influence should be exercised in a regular, invariable, and general manner; and in its expression great variety has been observed. Sex in some families would seem to modify the hereditary tendency, the females being attacked with one form of disease, and the males with another not analogous. This twofold effect of hereditary efficiency in the same family, would appear to be the result of a double influence, one disorder being derived from the mother, and the other from the father. In cases when the father and mother suffer under different constitutional disorders, a sort of crossing often seems to occur;—the disorder of the father attacking the girls, whilst that of the mother appears in the males. Generally, the hereditary pathological tendencies of the mother are more readily transmissible than those of the father.—C.]

It must not be supposed that hereditary proclivity to disease commences at birth. In a few instances, it is congenital; but in the greater number it is developed by growth or some other circumstances in life. Gout, for example, is acknowledged to be hereditary. A parent has it in middle or advanced life; his son does not get it until about the same period, sooner or later, according to whether he lives freely or not. Here is something transmitted from father to son, yet not manifest in the son for forty or fifty years. [It has been observed that diseases developed under the influence of hereditary predisposition, generally manifest themselves at an earlier age than that at which the same affection is ordinarily developed, independently of this predisponent cause.

There are other instances, and very curious and interesting they are, in which the children of a family succumb to a disorder of which the parents have never exhibited any traces, when subsequently the father, or mother, or both, are attacked, and thus the point of departure of the disorder, which had exercised a sort of anticipatory action on the offspring, is disclosed. This variety of hereditary influence has been frequently observed, and especially with reference to insanity, in which disorder the children are not unfrequently attacked before the parent. A well-authenticated instance of the same manifestation in tubercular disease, has been recorded by a late authority. A young man of 19 years of age, of fine constitution and great muscular development, after a violent physical exertion, was attacked with abundant hæmoptysis, and shortly afterwards well-marked phthisis appeared, and he soon died. Neither his father nor mother had exhibited any tuberculous tendency, or a young sister, the only remaining child. When she reached 19 years of age, the young sister was attacked with pulmonary tubercular disease, and succumbed; and it was not for two years subsequently that the mother, 53 years old, presented the first symptoms of consumption, of which she soon died, thus exhibiting the existence of an hereditary influence, whose effects had preceded the manifestation.—C.]

37. VI. Frequently, but not essentially, connected with hereditary conformation, is the peculiarity of constitution called TEMPERAMENT, which certainly predisposes to particular diseases. Temperament consists in a predominance or defect of some function or set of functions (§ 9).

38. Thus the *sanguine* temperament implies an activity of the system which circulates red blood, and a rich proportion of red particles, manifest in the excitable pulse and flushing cheek of those of this temperament; and further evinced in their quick movements and lively disposition. This temperament gives a disposition to inflammation, determination of blood, and active hemorrhage (§ 30).

39. The *phlegmatic* or *lymphatic* temperament is the reverse of the sanguine; it occurs in those with weak pulse and languid circulation, cold extremities, and pallid skin; there is a deficiency of red blood and of vascular action and tone (§ 9), and the proclivity is to watery fluxes, dropsy, and other chronic affections.

40. In the *bilious* or *melancholic* temperament, which is commonly

met with in persons of dark complexion and gloomy disposition, there is probably a defective action in some of the biliary or digestive organs, which are therefore the more liable to derangement (§ 9).

41. The *nervous* temperament is externally manifest only by agitation or trepidation of manner; it seems to depend on an excess or want of proportion of some properties of the nervous system (§ 9), and it predisposes to the disorders called nervous, such as hysteria, nervous pains, spasms, &c. These temperaments may be variously combined.

The word *diathesis* is often used to express a particular morbid tendency; thus we hear of the inflammatory diathesis, the scrofulous diathesis, &c. It is merely a term signifying disposition, without affording any clue to its true cause.

42. VII. The last head of predisponent causes to be noticed, is AGE. The several changes in organization, as well as in external circumstance, which the animal frame undergoes at different periods of life, may naturally be expected to be attended with corresponding proclivities to disease. I proceed to enumerate a few of these, premising that some of the examples may be entitled to rank under the head of exciting causes of disease, as well as under that of predisposition.

43 (*a*). [The organic conditions which obtain during infancy, as the general development of the system, the incessant and general activity of the nutritive forces, the predominance of the capillary circulation, give a special type to infantile pathology. Many diseases are so exceptional during infancy, that they may be said to form no part of its pathology; whilst others, common indeed to all ages, offer at this period of life distinct and special characters, as pneumonia, for example.—C.] *In early infancy*, the low calorific power of the body disposes it to suffer from the bad effects of cold (§ 17), whence the tendency to visceral inflammations. The skin is particularly liable to various eruptions, in consequence of its tenderness, and the new and drying medium in which it is placed. The redness of new-born children is obviously the result of the action of the air; it is often a vivid erythema, followed by desquamation of the cuticle, and a yellow stain of the skin from extravasated hæmatosin, which is erroneously thought to be a kind of jaundice. Strophulus and other papular eruptions often succeed, [with impetigo of the face and eczema of the scalp; œdema of new-born children is peculiar to this period of life.—C.] The comparatively virgin state of the alimentary canal at birth, renders it peculiarly susceptible of disorder; and a similar trial may occur at the period of weaning; hence arise diarrhœa, vomiting, colic, waterbrash, atrophy, and other ailments connected with disordered digestion, [with that form of enteritic disease called cholera infantum, the great desolator of the infantile population of our northern cities.—C.] The brain, excited by the novelties of the external world, becomes rapidly developed, and in its increased activity and growth, is liable to various diseases (§ 30); hence the proclivity to hydrocephalus, convulsions, &c. The process of teething adds an irritation, which, by its influence on the nervous system, the bowels, and the air-passages, disposes them to disorder. [In early infancy, rachitism, with gangrene of the mouth (cancrum oris), the various forms of stomatitis and angina,

as well as diphtheritic inflammation of the larynx and trachea, are frequently met with.—C.]

44 (*b*). *Childhood, or the age from infancy to puberty.*—The functions most active are those which administer to growth; the organs of digestion and assimilation are therefore obnoxious to disorder (§ 32); hence derangements of the stomach and bowels, worms, infantile remittent, &c. The activity of the nutritive function gives preponderance to the fibrinous or proteine constituent of the blood; and inflammations which may occur are often attended with the effusion of much plastic or albuminous matter; hence the products of croup, tubercle, mesenteric disease, &c. The natural mobility (or activity of the excito-motory system) of childhood predisposes to chorea and kindred affections (§ 30). [At this epoch, too, tuberculous affections of the bronchial ganglia, mesentery, peritoneum, and cerebral meninges, are of frequent occurrence, and present some peculiarities in their course and character, as do also some of the acute inflammations of the pulmonary organs, as bronchitis, pneumonia, the latter generally occurring in the form called lobular. Stridulous or crowing laryngitis, and hooping-cough, with the eruptive fevers, as scarlatina, measles, and variola and its modifications, are diseases of childhood.—C.]

45 (*c*). *Puberty* brings with it many morbid susceptibilities, chiefly in the female sex, in which the important function of menstruation is to be established. Many and serious are the evils that are liable to be produced by external causes, which check the development of this function. So also, when established, this function has its nervous as well as its vascular relations; and where it is irregular or disordered, a predisposition is given to many maladies affecting the bloodvessels and their contents, the secreting organs, and the nervous system.

[This is one of the most important periods of human existence, for during it the development of the organs of reproduction in the two sexes takes place, and the whole economy is brought to full perfection. The organs of respiration and of voice acquire their full growth and tone; the muscles their due proportion; and the cerebro-spinal system its complex and wonderful organization. The instinctive feelings and emotions reach their utmost limits; and many of them, especially those relating to the sexual organs, acquire an ascendency, and their indulgence becomes a cause of disease. From this source frequently spring impotence and the extinction of families; the infliction, during after life, of many of the disorders which proceed from debility, and the exhaustion of the nourishment and vital energy of the various organs; innumerable nervous and convulsive maladies, as hysteria, epilepsy, neuralgia, chorea, melancholia, mania, idiocy, &c.; diseases of the heart; disorders of the digestive organs; premature alopecia, and old age; the formation of tubercles, and the production of pulmonary consumption; and lastly, the transmission of weak and decrepit bodies and minds to the offspring—scrofula, rickets, marasmus, hydrocephalus, &c. The pathological tendencies of this age are especially characterized by exalted action. At the approach and commencement of puberty, the glandular system is extremely prone to congestions and inflammations, particularly the lymphatic ganglia of the neck and axilla. Tubercles are

rapidly developed in the lungs, and these organs are much disposed to acute and chronic inflammations of their substance and mucous surfaces; pulmonary hemorrhage replaces the epistaxis of childhood, and in females dysmenorrhœa, protracted menstruation, amenorrhœa, leucorrhœa, chlorosis, and hysteria appear.—C.]

46 (*d*). *At the termination of growth*, there is another critical period. The cessation of that appropriation of nourishment for the increase of the body, that had hitherto been going on, may cause fulness of the vessels, and a disposition to hypertrophy, hemorrhage, and inflammation, in the more robust; and in the cachectic, to morbid depositions, especially of the tuberculous kind (§ 47). The same redundancy of the vivifying fluid in active circulation, gives that buoyancy of animal spirits and impulsive energy of feeling and strength, which are the characteristics of healthy youth; yet this very exuberance of vital power, if not properly controlled and balanced, may constitute a tendency to disease; either directly, as where excitement rising beyond the limits of health borders on morbid action (§ 31); or indirectly, by leading to excessive exertion and subsequent exhaustion (§ 23). Youth is the age of susceptibility to moral and physical impressions; and therefore of liability to the disorders which these are capable of producing.

47 (*e*). *Adult age* can hardly be said to predispose to any diseases, unless it be those arising out of mode of life. It is commonly a period of steadier health, because the functions are more evenly balanced; but if the mode of life be unfavorable, bad habits are apt to become established, and by their continuance to induce disease. Thus gout, gravel, rheumatism, indigestion, and various other disorders, are apt to occur in middle life, because the predisposition to them is gradually engendered (§ 24) by some error in diet or regimen, too slight to excite disease, but sufficient by accumulation to dispose to it, on the addition of an exciting cause. [As the age of fifty is approached, the circulation becomes more languid, particularly that of the venous system; hence the frequency of venous congestions and visceral obstructions, with the numerous train of disorders they occasion; as hemorrhoids, inflammations of the great cavities, affections of the heart, apoplexy, paralysis, derangements of the stomach and bowels, gout, rheumatism, diseases of the urinary organs, hysteria, and uterine disorders, hypochondriasis, and mental alienation. It is asserted that ataxic phenomena are more frequent accompaniments of severe disease at this than at any other period.—C.]

As *age* advances, such habits affect the organization, and accelerate those changes in the fabric, by which our existence is limited to a span of years. It would occupy too much space to enter into the details of all these changes, but some of the principal may be briefly noticed, as illustrating the weaknesses and liabilities of *advanced age*.

48 (*f*). The changes which *old age* induces in the exterior of the body shows a failure of those functions which were active in youth. Instead of muscles, fat, and integuments being nourished in the equal proportions that give beauty as well as strength to the form in mature life, the muscles become thin and sinewy; fat becomes scanty, partial, or in excess; the integuments are loose and wrinkled, or fat and flabby; the

joints stiffen, and the gait loses its firmness and uprightness. These changes in the textures of the body are attended, and probably induced, by altered proportions in the different parts of the vascular system. The pallid skin of age, contrasted with the ruddy blush of youth, proves the diminished development of the capillary bloodvessels, that great system which sustains the life and nutrition of the body; hence much of the blood that in earlier age circulated on the surface, giving vigor and sensibility to all the external organs, and life and susceptibility to all outward relations, is now accumulated in the interior, and confines its vivifying and nutrient influence more to the internal functions and structures, thus tending to render the individual more isolated and selfish. But the blood thus abounding in the larger vessels is not equally distributed within them. The diminished capillaries intercept some of the force by which the blood is propelled through the arteries; hence this fluid stagnates and accumulates in the veins, which become distended and tortuous, whilst the arteries, exposed to the continued impulsive force from the heart, lose much of their elasticity, and become mere rigid tubes, causing the peculiar hardness of the senile pulse. The nutrition of the textures generally fails in activity, not in degree only, but in kind also, chemical transformations and deposits beginning to show themselves in the different structures. Thus fibrous and muscular tissues exhibit partial conversion into fatty matter, and osseous or petrifactive changes encroach on many structures of low organization; exhibiting a tendency to degradation to the composition of mere vegetable and mineral matter.

This altered proportion of the bloodvessels brings with it morbid tendencies, the nature of which will depend much on the great moving power, the heart; now more than ever the prime agent in the circulation. If the heart be moderately strong, a fair balance may long be sustained; although hemorrhoids, varicose veins, and such irregularities from local obstructions, may occur. If the heart be too strong (which is often the case after a life of much muscular exertion), the small arteries may suffer from the unsoftened force of its pulses, particularly in the brain, and there is a liability to apoplexy or palsy; and in mucous membranes, there is a disposition to active fluxes; hence catarrh, asthma, and affections of the urinary organs. The more vascular textures, especially of internal organs, are over-nourished, and increase in size or weight. If the heart be weak or diseased, there will be imperfect circulation and tendency to venous congestions, dropsical effusions, imperfect and disordered secretions, altered nutrition, and a general failure of all the functions which depend on a sufficient supply of arterial blood; hence may arise diseases of the liver, stomach, kidneys, lungs, and in fact of any of the viscera; in extreme cases, the lower extremities actually die for want of circulation.

If, instead of the organs of circulation, we were to take the alimentary, the respiratory, or the urinary apparatus, we should here too find changes induced by age, which show the necessarily limited time that man's organization is intended to last. Old age is thus attended with increasing infirmities and liabilities to disease (§§ 16, 18). The very strength and activity which some functions retain, may, from their partiality, en-

danger life ; and their gradual and more equal failure degrades the physical and often the mental frame of man to a lower scale of existence, until he sinks into second childhood, dotage, and imbecility.

49. VIII. Sex.—The liability which sex gives to the diseases of the respective generative organs, is too much of a truism to need mention. But the peculiarities of sex are not confined to these organs; they extend to many of the structures and functions of the body.

The male sex is remarkable for the higher development of the muscular and voluntary excito-motory system, with a corresponding strength of frame; for the stronger impulses of the animal passions; and for a greater endowment of the reasoning faculty. These respectively bring with them a liability to suffer from diseases of the muscles, limbs, joints, heart, and great vessels; from the evils contingent on undue indulgence of passion or appetite; and from disorders of the brain and its intellectual functions.

In the female sex, the predominant bodily functions are the nutritive, the sensitive, and the involuntary excito-motory; whilst the perceptive and instinctive faculties and moral emotions preponderate in the mind. Hence the greater proneness of females to changes in flesh and blood; to disordered sensation, spasms, convulsive and other affections of the spinal system; and to the direct and indirect consequences of the indulgence or thwarting of instinctive and moral feelings. The predisposing influences of the menstrual function have been before noticed (§ 45); it may be now added, that its cessation favors the development of various diseases of function and structure, especially growths, simple and malignant.

50. IX. Occupation comprises many circumstances already noticed under the heads of predisposing influences. Thus sedentary occupations include want of exercise (§ 24), and sometimes impure air (§ 22); laborious employments operate as excessive exertion (§ 23); other occupations may predispose to disease by the continued exposure to heat (§ 25) or cold (§ 26) which they occasion. Some employments require constrained postures, which, if insufficient to induce, may yet promote the occurrence of disease; thus engravers and watchmakers are liable to affections of the head from holding the head low; shoemakers and tailors are subject to disorders of the stomach from their stooping forward at their work. In many other instances, occupations induce disease rather by exposing the individuals to the exciting causes, than by inducing a predisposition; but, as before remarked, the very circumstances, which in great intensity suffice to excite disease, in a lower degree may only induce a disposition to derangement. Thus the slow introduction of lead into the system, occurring in the occupations of painting, plumbing, card-enamelling, and printing, *may* not cause colic until cold or irregularity of diet becomes an additional or exciting cause. The same remark will apply to dry grinding, needle-pointing, leather-dressing, and other unhealthy occupations. An important element in the influence which employments have in causing disease, is the time during which they are pursued; thus an occupation, not in itself unhealthy, may become so

when continued too many hours in the day; and a work which is attended with risk, may be often safely undertaken for short periods with a due amount of relaxation or diversion to another pursuit. By attention to this point, the injurious influences of occupations may be much lessened.

SECTION III.

EXCITING CAUSES OF DISEASE.

51. We now pass to the consideration of *exciting* or *occasional causes* of disease, or those circumstances and agents which, operating on the body, especially when predisposed (§ 14), may excite disease in it. It has been stated before (§§ 11, 15), that certain powerful agents, such as irritants or poisons, pretty surely cause disease, independently of constitution or predisposition; but constitution or predisposition may much modify the character of this disease in different cases; and where the agents are less powerful, as in the case of common causes of disease, the effects will depend still more on the predisposition, and may be null where this is not strong (§§ 15, 19).

Exciting causes may be divided into COGNIZABLE and NON-COGNIZABLE agents. The former class comprehend physical and mental agents, of whose existence we can take cognizance, independently of their operation in producing disease; thus cold, we know by its effect on our instruments and sensations; muscular exertion, by our witnessing or performing it; and mental emotion, by our consciousness of it. The *non-cognizable* causes, on the other hand, elude our senses, and we infer their existence only from their morbific effects; thus malaria and infection we know by no other property than that in question. The subjoined table includes both classes.

EXCITING CAUSES OF DISEASE.	I. Cognizable Agents.	1. Mechanical.	
		2. Chemical.	
		3. Ingesta.	
		4. Bodily exertion.	
		5. Mental emotion.	
		6. Excessive evacuation.	
		7. Suppressed or defective evacuation.	
		8. Defective cleanliness, ventilation, and drainage.	
		9. Temperature and changes.	
	II. Non-cognizable Agents.	1. Endemic	Poisons.
		2. Epidemic	
		3. Infectious	

I. COGNIZABLE AGENTS.

52 (1). *Mechanical causes, which injure structure, or impede or derange function.*—Besides the obvious instances of tearing, cutting, pinching, striking, and straining, which produce at once diseases which fall under the province of the surgeon, the physician finds many mechanical

causes of diseases which he has to treat. Long-continued pressure of articles of clothing may produce disease. Tight neckcloths may cause headache, or even apoplexy, by impeding the flow of blood from the head. Tight stays may cause fainting, by pressure on the heart and great vessels; or colic and costiveness, by obstructing the free passage through the great intestines. Pressure on the epigastrium, by sitting at a desk after a meal, may cause indigestion. Long continuance in one position, whether standing, sitting, or lying, will partially obstruct circulation and innervation, and produce swelling and paralysis of the lower parts, or of those beyond the seat of pressure, and in time may cause inflammation and death of the parts pressed upon. Mechanical causes also operate within the body. A stone in the bladder irritates by its mechanical properties, especially if it be of an irregular shape; or it mechanically stops the flow of urine; so also may a gall-stone that of the bile. The intestinal canal is sometimes mechanically stopped by hardened feces, and irritation and inflammation may ensue. The stomach is often irritated by the mechanical qualities, bulk, hardness, or asperities of its contents; thence may ensue vomiting, indigestion, or inflammation of the organ. The air-passages of needle-pointers, stone-masons, &c., are irritated and inflamed, and at length altered in structure, in consequence of the mechanical action of particles of stone or other substances, which these men are continually inhaling in the course of their employment.

Such instances are endless; and the further effects of disease are also in great measure mechanical. For example: the influence of tumors, of diseases of the heart and vessels, the lungs and air-passages, intestines, and urinary apparatus, injuries and diseases of the bones and ligaments, &c. &c., is in great part mechanical, interfering with the natural mechanism.

Besides their simple mechanical effects on structures and functions, some mechanical injuries, when extensive, directly depress the vital powers; thus, concussion of the brain, crushing or tearing off a limb, or a blow on the epigastrium, causes fainting and extreme weakness of the heart's action, and may thus cause death. Slighter mechanical injuries are causes of irritation or excitement, which may be local or general, according to the excitability and extent of the part irritated.

53 (2). *Chemical causes* of disease are even more varied than mechanical, because chemical agents are more numerous. We are acquainted less with the chemistry than with the mechanism of the animal body, and therefore can less distinguish causes which act by chemical properties from those which have complex relations to vital properties. But we recognize chemical irritants in acids, alkalies, and many salts, whether applied to a part, or inhaled in form of gas or vapor. So what are called chemical poisons, such as corrosive sublimate, and other metallic salts, the strong acids and alkalies, iodine, chlorine, &c., produce disease by their known powerful chemical affinities, which tend to decompose tissues and disorder functions.

We cannot doubt that many of the matters which cause disease in the alimentary canal, do so by virtue of their chemical qualities. The process of digestion, although always in part chemical, is so under the

superintendent influence of a superior vital power; no sooner does this power fail, or the chemical agencies or decompositions become too strong for it, than we have fermentation and putrefaction, which cause eructation of gas or sour liquid from the mouth, and there may follow the discharge of ill-colored, and unusually fetid matter by stool; then, too, may arise a number of disorders, which may in great part be referred to the influence of these injurious chemical processes.

There appear to be at least four modes in which chemical agents may excite disease in the body:—

1. As *local irritants*, as the diluted acids, alkalies, and various salts, the chemical operation of which is resisted by increased action excited in the part (§ 16). [The carious maxillæ of the workmen exposed to the vapors of phosphorus, would appear to be due to this cause.—C.]

2. As *corrosives*, as in the case of strong acids, alkalies, some metallic salts, chlorine, and iodine, which, by their powerful chemical affinity, so completely overcome the vital affinities of textures as to decompose them, and thus to kill and alter the condition of the part.

3. As *septics*, promoting the spontaneous decomposition of the fluids or solids of the body, in the same way that ferments or putrescent matters operate on dead organic matter.

4. As *chemical alteratives*, modifying the changes which take place in digestion, assimilation, transformation of textures, secretions, &c., as in counteracting acidity by alkalies, in variously influencing the state of the blood and urine by acids, alkalies, &c.; and in causing the production of hippuric acid in that excretion, by the administration of benzoic acid. (Ure.)

The operation of chemical agents on the whole body will vary according to their intensity and extent. Irritants, if extensively applied, cause feverish excitement. Corrosives, if acting widely, depress the vital powers, like the shock of violent mechanical injuries (§ 52); if partially, the vital powers are excited to resist them, and they operate as irritants. Septics, if very powerful, may speedily overwhelm the preserving vital powers of the body, which then speedily passes into a state of corruption, as in the case of extensive gangrene, pestilential diseases, &c.; but if the septic matter be scanty, and the vital powers strong, they are excited to increased action, and by means of accelerated circulation, and augmented excretions, the body may get rid of the offensive matter (§ 17). Such struggles are instanced in typhoid fevers, epidemic cholera, dysentery, &c.

54 (3). *The solid and liquid ingesta* are a fertile source of disease, and in various ways. Their mechanical and chemical properties have already been noticed (§§ 52, 53). But further, the ingesta may cause disease—

a. By non-alimentary matters acting injuriously.

b. By aliment defective or ill-proportioned in quality.

c. By aliment defective or excessive in quantity.

55 (*a*). Of the *non-alimentary matters* contained in the ingesta, salt, spices, pickles, and other condiments, and spirituous or fermented liquors, are frequent exciting causes of disease. They are all more or less irritating or stimulating to the digestive apparatus; and if used in-

discreetly, may induce inflammations, congestions, and functional disorders of these organs, and, in some instances, irritation of other parts, and of the whole system. Salt in excess irritates the stomach, retards digestion, and causes feverishness with thirst. Much of these effects is due to the affinity of the salt for the water of the animal fluids, and may be induced by other saline matters, besides common salt. Wherever excess of salt is contained in the body, there will be exosmosis and endosmosis of the water from the adjoining vessels and tissues, until the salt is equally distributed among them; and before this is accomplished, there will be such a diminution of the fluids within the blood-corpuscles, and on the surface of membranes, as may readily account for the thirst and disturbance caused in the system. According to Liebig, salt impedes the deposition of fat. Animals will not fatten on salt food; a hint for the corpulent.

56. But the operation of intoxicating liquors is more extended; being soon absorbed, their stimulant action is speedily exercised on distant parts, especially on the vascular and nervous system. Being absorbed by the veins, they pass by the portal vein into the liver, the function and structure of which are particularly apt to suffer from excesses, especially when spirits have been freely indulged in. So, too, the kidneys, which are the natural emunctories through which such extraneous matters are eliminated from the system, are often over-stimulated, and are injured in their secreting power, and ultimately in their structure also. The heart and vessels are over-excited at first, and afterwards lose their tone; and the processes of digestion and nutrition become impaired and modified. The nervous system is an especial subject of the disordering influence of intoxicating liquors. A large quantity taken at a time is a narcotic poison, inducing a short period of cerebral excitement or intoxication, followed by insensibility, in which the functions of the brain are more or less completely impaired, and in extreme cases those of the spinal marrow suffer; and if the influence be insufficient to stop respiration, yet it may be imperfectly performed, and congestions are formed in the brain and other organs. Hence apoplexy, palsy, phrenitis, or delirium tremens, may follow, and the whole frame may suffer from the effects of the poison. Even when less excessive quantities are taken, and their first effect is mere intoxication, the headache, sickness, and inappetency, and the feelings of wretchedness and depression which often ensue, sufficiently prove that disorder has been produced, and that such artificial excitements cannot be abused with impunity.

The habitual indulgence in strong drinks causes further varieties of disease, which are so prevalent as to deserve notice. When taken only or chiefly with food, not as a substitute for it, but as a constituent of general "free living," they contribute to the production of an abundance of ill-assimilated, overheated blood; which either finds its vent in eruptions on the surface, or in local hemorrhages or fluxes, or causes various functional disorders, such as palpitation, vertigo, stupor, dyspepsia, bilious attacks, &c.; or may tend to the production of a fit of gout or gravel. The latter results are promoted by such beverages as contain much free acid as well as an abundance of spirit; such as port wine, rum punch,

and hard strong beer. The less acid malt liquors, ale and porter, tend rather to induce liver disorders, and an abundant deposition of fat in the body. All these consequences will be much favored by sedentary habits (§ 24) and deficient excretions; active exercise carries off much of the spirit and superfluous aliment by an increased elimination of the acids of respiration and perspiration.

The most disastrous consequences of intemperance are exhibited by the habitual drunkard, who, in proportion as he indulges in liquor, loses his appetite for food, and his power of digesting it. He then drinks and starves, and the disease which ensues comprises the exhaustion of inanition with the more direct effects of the alcoholic poison. Thus, in delirium tremens, the drunkard's disease, together with the permanent restless excitement of the irritated nervous system, which adds more and more to the exhaustion, the weakness of mind and body is fearful, and in bad cases affect even the organic functions, so that the pulse is very weak and frequent, the excretions scanty and depraved, and the respiration is too imperfectly performed by the involuntary powers to permit sleep to ensue. This exhaustion must soon terminate in death, unless prevented by appropriate treatment; and this must comprise, besides opium (the common remedy), ammonia and other stimulants to the circulation and respiration; purgatives and diuretics to free the blood from the excrementitious matter that has accumulated in it; and fluid nourishment to repair its waste. Without these adjuncts, opium will not only fail to procure sleep, but its narcotic influence may extinguish the flame of life.

Pernicious as fermented liquors are in their abuse, yet these and other adjuncts to food, when taken with careful moderation and discrimination, often prove beneficial by aiding the digestion where it is weak, and by counteracting various exhausting and depressing influences, which are frequently arising out of the artificial condition and employments of society, especially in large towns and in cold climates. Total abstinence, therefore, is preferable to moderation, only because it is morally easier to practise, not because it is more salutary in its physical effects.

57. Disease may be excited by unwholesome articles with which the food is adulterated. To this class of causes belong various poisons; the operation of some of these will be noticed under the head of modes of death (see chapter on PROGNOSIS); but for further details, works on toxicology and materia medica must be consulted. There are some noxious matters occasionally mixed with food, which gradually produce deleterious effects. Thus salted provisions too long used will cause scurvy; ergotted corn has been known to produce dry gangrene. Lead, gradually introduced, causes constipation, colic, paralysis, and atrophy. Impure water, used as a drink, is a common cause of disease; containing decaying vegetable or animal matter, it may induce sickness, diarrhœa, cholera, and typhoid symptoms; hard waters, which are impregnated with some of the salts of lime, render the bowels costive, and are supposed to favor the production of calculous diseases and bronchocele; brackish waters, containing saline matter, may induce dyspepsia and diarrhœa; chalybeates, containing iron, are constipating, &c.

Under the head of non-alimentary ingesta which may cause disease,

we must reckon various medicines; and that not only when injudiciously administered, but as commonly prescribed; the remedies *necessary* to cure or relieve many diseases, are not uncommonly *necessary evils;* they remove one disorder by inducing another, and it is well if the evil thus induced is the smaller of the two.

58 (*b*). Aliment unfit in *quality* is another condition of the ingesta that may cause disease. Man is by nature and habit an omnivorous animal; and in general, his health is best maintained by mixed proportions and varieties of animal and vegetable food. The insalubrity of the simpler constituents of food, when separate, even those supposed to be most nutritive, has been well shown by the numerous experiments of Magendie, Gmelin, and others. They fed dogs, geese, donkeys, and other animals, on articles which are generally considered highly nutritive, as sugar, gum, starch, oil, or butter; the animals died with symptoms of starvation almost as soon as if they had been kept without food. Even bread, when too fine, is insufficient for nutriment. A dog fed on pure white bread lived only fifty days, whereas another fed with the coarsest brown bread was well nourished, and seemed capable of living to an indefinite period. According to the researches of a commission of the French Institute (the report of which was published in 1841), animals fed on pure fibrine, or albumen, or gelatine, die of starvation, with reduced quantity and quality of the blood, almost as soon as if not fed at all. Gluten, or vegetable albumen, is the only simple principle which will alone maintain life, and the nutritious qualities of vegetable food depend chiefly on the quantity of this azotized principle which they contain. Bread may, therefore, well be called the *staff of life.* Even animal albumen and fibrine require mixture with vegetable matter to make them properly nutritious as well as wholesome; and gelatine and oily matters are still less available for nourishment without much combination. In the experiments just alluded to, animals could be supported on meat or flesh, which comprises several of the elementary matters, although they were not sustained by any one of these matters separately.

The utility of a due combination of organic elements for the food of animals has long been ably shown by Dr. Prout, who has pointed to Nature's aliment, milk, as the great type of all proper kinds of nourishment; as it contains albumen, oil, sugar, and water, so all other kinds of food used for ordinary sustenance, ought to include these elements, or others isomeric (that is, identical in ultimate composition) with them; and it is quite true that all combinations of food sanctioned by custom, do comprise such ingredients. Bread contains two of these, gluten, which is vegetable albumen, and starch, which is isomeric with sugar; but bread is not relished without butter or some fat with it. Neither does meat, which contains albumen and fat, suit the taste without a combination with bread, rice, potatoes, or some vegetable, which represents the amylaceous or saccharine principle.

59. Much discussion has occurred of late as to the share or purpose which each of the elements of food serves in the animal economy, and the extent to which they can be changed by the process of digestion and assimilation. Dumas and the French chemists generally have maintained that this process is limited to the separation and appropriation of princi-

ples ready formed in the food, and does not extend to the conversion of one into another. Thus all the albumen or fibrine in the body is derived from the albumen or gluten of the food; and all the fat from fat or oil contained in the nourishment. This view, as regards the formation of fat, is opposed by many familiar facts, such as the fattening of domestic animals with farinaceous and vegetable foods, which contain very little fat; and it has been completely negatived by the experiments of Petroz and Boussingault, which have proved that geese and pigs, during the process of fattening, gain more fat than is contained in their food.[1] It further appears probable that the conversion of sugar into fat is promoted by the agency of bile; for H. Meckel found that, by keeping a mixture of bile and grape sugar at a warm temperature, the quantity of fat in the mixture increased to double in five hours, and more than treble in twenty-four hours. It is pretty certain, therefore, that fat may be formed from starch or the saccharine principle, and probably from the albuminous also. But there is no decisive evidence to show that albumen or gelatine can be elaborated from fat, starch, or sugar, at least under common circumstances; and it is certain that these elements alone will not long sustain animal strength or life.[2]

Baron Liebig has advanced a very comprehensive hypothesis with regard to the purposes of the different proximate elements of food. He considers that the albuminous principle alone supplies the material from which the textures are nourished, and all the non-nitrogenous elements are converted into carbonic acid and water by the process of respiration for the production of animal heat. Although too exclusive to be fully admissible, the general outline of this view appears to be consistent with facts, and will assist us in studying variations in food as a cause of disease.

60. The chief alimentary matters may be divided into the *albuminous*, the *gelatinous*, the *oleaginous*, and the *saccharine*, or *amylaceous;* and we shall briefly consider how an excess or defect, and in some instances the quality, of each of these may operate in causing disease.

Albuminous or *proteinaceous* articles, such as the lean of meat, fowl, and fish, gluten of bread, and caseine of milk, are those which supply the albumen and fibrine of the blood and textures of the body. Hence *defect* of this kind of nourishment will cause first, weakness of the heart and other muscles, and at length wasting of these and of other textures, with diminution of the quantity and richness of the blood. *Excess* of carneous food, particularly the richer kind, butcher's meat, tends to cause plethora, with an excited circulation and feverishness, which may result in hemorrhage, inflammation, gout, lithiasis, &c.

Bad quality of albuminous food is peculiarly injurious to persons of weak digestive and assimilative powers; thus the caseine of cheese

[1] Dr. Day's Report on Chemistry, in *Dr. Ranking's Abstract*, July, 1846 [p. 273, Am. Ed.].

[2] In a very able paper on Vital Affinities, just published by Dr. Alison (*Transac. of Royal Soc. Edin.* 1847), he adduces many arguments in favor of the inference that albumen may be formed in the animal body, especially in vigorous health; and he suggests that the intervention of ammonia can furnish the material from which starch and other non-azotized articles of food receive azote, and by the power of the vital affinities are converted into albumen. There is much reason on the side of this notion; it may be seen that I have long entertained a similar opinion with regard to the conversion of gelatine into albumen.

the fibrine of stale or salted meats, and the gluten of sour or ill-baked bread or heavy pastry, instead of forming good proteine, is apt to degenerate into the products of animal decay, lithic and lactic acids, urea, &c. Hence may arise gout, rheumatism, calculous disorders, &c.[1]

Gelatinous foods, soups, broths, isinglass, jellies, &c., are by no means so supporting as albuminous matters; but when combined with bread, they nourish the body so well that it seems very probable that, in a healthy constitution, gelatine may assist in the formation of albumen; but when used in excess, or to the exclusion of bread and meat, it ceases to be nutritious, and the strength and flesh will waste.

Oleaginous or *fat* nutriment (butter, fat of meat, oils, and seeds containing them), not only supplies the material for the adipose textures of the body, but it assists in the formation of other structures and secretions (oil globules forming a normal constituent of them), and it affords the strongest fuel for the maintenance of animal heat by respiration. From what has been before stated (§ 59), it may be inferred that fat may also be formed from saccharine and starchy food, as well as from the storehouses of the adipose membrane; but *defect of fat* in the food has been observed to induce the following morbid results; loss of flesh, especially of the rounded plumpness and smoothness of the surface, which becomes skinny, wrinkled, and often dry and scurfy; deficient secretion of mucus at the orifices of mucous passages, and of synovia in the sheaths and joints; insufficient formation of bile, and consequent imperfect digestion and feculent excretion, with diminution of animal heat. *Excess of fat food* may disorder the stomach, by its indigestibility, becoming rancid, and causing heart-burn or sickness, and sometimes a bilious taste; for much fat seems to induce a regurgitation of bile into the stomach, which is supposed to assist in its digestion (Beaumont) and absorption (Matteucci). If the fat is carried into the blood, it may cause inconvenient obesity by its accumulation in the adipose texture of various parts of the body; or if the subject be naturally lean, and incapable of accumulating fat, the superfluity must be carried off, and the natural emunctories, the sebaceous follicles of the skin, and the liver, may be disordered; hence acne and other follicular diseases of the skin, and various bilious disorders, will ensue. These results will be more readily produced in sedentary persons, in whom the exercise of the lungs is insufficient to consume the superfluous fat. On the contrary, those who use active exercise can often take considerable quantities of fat with impunity, and sometimes with advantage. For similar reasons, oily food is better borne in cold than in hot climates and seasons; thus, as Liebig has pointed out, the Laplander relishes train oil, which serves to sustain the warmth of his body; whilst the Italian, in a sunny climate, prefers the less combustible food, maccaroni and fruit, which nourish without heating.

[1] In this statement I disregard the dogma of Liebig, that the materials of food serve for respiration and nutrition only; and that urea, lithic acid, and excrementitious matters are derived from the decay of the tissues alone. Daily observation convinces the medical practitioner that in persons of weak assimilation, certain articles of food, as specified above, so certainly and promptly cause an increase of animal matter in the urine, that there can be no doubt that they are the direct sources of it.

The *quality* of oily matter in the food is materially concerned in its morbific effects, those most prone to chemical change or to become solid, being more likely to disagree than others. Thus stale or tainted butter or fats, and rancid oils, are peculiarly offensive to the digestive organs, both from the production of injurious acids (butyric and oleic), and from their spissitude rendering them incapable of the minute division necessary for their absorption and appropriation to the nutritive process. On the other hand, fresh butter, mild fat, and sweet salad oil, agree well and nourish, especially when intimately blended with farinaceous or succulent vegetable matters; and the cod-liver oil, when freed from its impurities, is often borne by the weakest stomachs.

Amylaceous or *starchy* foods, such as arrowroot, sago, tapioca, and many kindred preparations of farinaceous articles, although isomeric (*i. e.* consisting of the same elements) with *saccharine* matter, are not quite similar in their physiological effects. Like it, they probably sustain the body rather by supplying a material for the process of respiration, than by nourishing the textures; they thus save them from the consuming influence of the oxygen absorbed through the lungs; and if taken in *excess*, they may either lead to the formation of fat (§ 59), which is deposited in the textures, or, passing into fermentation, they may give origin to acetic, lactic, and oxalic acids, and other matters of an injurious tendency; and this latter effect occurs more from saccharine than from amylaceous food. On the alimentary canal, too, their effects in some degree differ, amylaceous food in excess impairing the action of the intestines, and the secretion of the liver, whereas sweet things often relax the bowels and cause a redundancy of bile. These different effects of saccharine matter are probably connected with its either often containing or readily forming vegetable acids, which irritate the alimentary canal, and which may become causes of dyspepsia, diarrhœa, diabetes, rheumatism, oxaluria, and other disorders of the same class.

Amylaceous and saccharine matters, forming the mildest materials of food, serve to dilute the stronger articles, fibrine and oil, and to render them both more palatable and more digestible; when, therefore, the former are *deficient*, the latter are more apt to disagree, and fail to impart their nutrient properties. These and other vegetable principles such as gum, vegetable jelly, extractive, &c., also contain an alkali combined with vegetable acids which are decomposable in persons of strong digestion, and this alkali becomes useful in counteracting the acidity which results from the processes of transformation continually proceeding in the body. Thus fruits and other vegetables assist in neutralizing and eliminating lithic acid, and in preventing the occurence of gout and gravel. This statement is in accordance with the views of Prout, Liebig, and Wohler; but I have restricted its application to the case of persons whose digestion is strong; for in those of feebler powers, I find commonly that vegetable acids and fruit increase the acidity of the urine, and are therefore injurious; whether by passing unaltered through the circulation, or by irritating the primæ viæ, and thus leading to an unusual development of hydrochloric and other unchangeable acids, I cannot say, but the latter would appear most probable.

61. Thus the selection and combination of articles proper for food would be a difficult task, requiring much scientific knowledge and calculation, were it not that Nature has supplied us with an instructive guide, which happily adapts itself to the varied wants of the system, in change of season and other circumstances. The appetite and taste generally instruct us pretty safely as to the best proportions of different kinds of food; but they must not be perverted and pampered by condiments, and refined modes of cooking. These are expedients to coax and deceive the appetite and taste; and if these guardians of the nutritive department are cheated, it is no wonder that the department becomes deranged.

62 (*c*). Aliment may be *excessive* or *deficient* in *quantity*. Sometimes the appetite is inordinate; more frequently it is pampered; in either case, if gratified, *more food* is taken than the expenditure of the system requires. If the digestive organs fail in appropriating the nourishment, they become distended, irritated, and otherwise disordered by what they cannot digest. If they are strong, and digest the excess, they send too much chyle into the blood, over-distend the vessels, and derange the function of assimilation; hence may result plethora, apoplexy, gout, gravel, or some congestive hemorrhage, or inflammatory disorder, to which the individual is predisposed (§ 14). Such evil consequences of repletion will ensue the more readily in sedentary persons, in whom the waste of the body is little, and the excretions scanty.

63. *Defective* nourishment may excite various disorders. In the extreme case of privation of food, the cravings of hunger are alternated with nausea and a sense of sinking; then follow extreme depression alternated with transient fever, delirium, and general disorder both of body and mind, with increasing feebleness, and inability to maintain animal heat. It is a curious fact, that, in this state, the stomach becomes inflamed; probably from the irritating action of its secretion on its unrelieved vessels. Even in less degrees of abstinence, enjoined in the treatment of disease, symptoms of vascular and nervous irritation often arise in the midst of general weakness. By many practitioners of the Broussaian school, these symptoms are erroneously taken as indications for an increase of the antiphlogistic plan, when a judicious return to nourishing food will really prove the best cure. Deficiency of food, if long continued, causes general weakness of the functions, and wasting of all the textures, except those of the nervous system. The blood becomes thin and easily extravasated; the gums spongy and bleeding; fat disappears; muscles become thin and flabby; the legs œdematous; diarrhœa often occurs; ulcers appear in the cornea and other parts which are least vascular; a state of scurvy or cachexy is induced, from which, if advanced, an improved diet may now fail to restore. Chossat found that, in animals gradually starved to death, the temperature progressively declined, and, unless maintained artificially, the animals seemed to die of cold. All the textures, even that of the bones, sustained great loss of weight; but those of the nervous centres far less than any others. This fact I would explain by the peculiar condition of the bloodvessels supplying these centres, which enables them to monopolize the little blood remaining; and thus we gain a further interpre-

tation of the predominance of nervous symptoms in persons suffering from inanition. (See ANÆMIA.) In less extreme cases, poor living may excite scrofulous and tuberculous disease, and other kindred forms of degeneration of organs. The bad influence of poor living is much more felt in those who are confined in close habitations, as in prisons, poor-houses, the cabins of ships, and besieged towns, than in those who are at large (§ 22); and it is under such circumstances, that the insalubrity of some kinds of food, however nutritious, becomes apparent. Thus, even bread, with meat or broth, will not preclude the occurrence of scurvy; but a sufficient addition of fresh vegetables, and even of potatoes, prevents this disease from appearing.—(Dr. Baly, *Med. Gazette*, Feb. 1843.)

[Chossat has shown that by nourishing any animal insufficiently, instead of totally depriving him of nourishment, the period of death is delayed, but it does not change the law that death occurs sooner or later inevitably. In both cases, the animal dies as soon as his weight attains the limit of diminution compatible with life. Before the decisive experiment of Chossat, many observers, Regnault, Reiset, and Hebray amongst others, had shown that the effects of insufficient nourishment were similar to those following complete inanition. The progress of the phenomena of the two sets of causes in the animal economy, offers only the differences which we notice in the course of an acute and a chronic affection. In both instances we have vomiting, diarrhœa, progressive cerebral debility, and muscular atony so complete, that the natural function, contractility, is destroyed. The action of the stomach ceases, the ingesta act as foreign bodies whose presence induce gastric irritation, veiled by the general dynamic disturbance. Every cutaneous solution of continuity, no matter how slight, becomes an intractable sore, attended with hemorrhage. Finally, convulsions, complete neurosthenia, intense marasmus, and death.

Defective nutrition plays a large part in the direct production of diseases. Fever, malignant dysenteries, and other disorders of that class, have been the invariable attendants on all the great famines in Europe. The following graphic description of the effects of insufficient nourishment in the last great famine of 1846–47, which ravaged Ireland, the Belgian Flanders, a portion of Germany, and several departments of France, is from an eye-witness, M. de Mursman: "The first stage of the disorder was characterized by all the symptoms belonging to an impoverished condition of the blood; palor, loss of flesh, sadness, depression, difficult digestion, flatulence, disordered dejections, distension of the abdomen, œdema of the extremities, either suppression or unusual abundance of the menstrual discharge, sterility, general debility of the muscular system, pain in the limbs, embarrassed and painful locomotion, and impossibility to labor. In this condition the human being merely vegetated, and dragged on a miserable existence, soon, however, to experience trials still more severe; for, in proportion as the state continued, and in direct proportion to the debility in each individual, chronic affections peculiar to his constitution or his profession were developed; specific disorders, which had remained stationary, in a static embryonic condition, or one of simple predisposition, broke forth violently. Hence, syphilitic affections, psoric, strumous,

cancerous, herpetic, dartrous disorders, pursued their ravages, and claimed the first victims in this alimentary crisis. Of all the cachexiæ, phthisis pulmonalis furnished the largest contingent to the bills of mortality. The unfortunate beings who did not succumb to some one of the affections which privation had produced, and in whom some remains of organic vigor still existed, became daily more and more debilitated under the influence of a diet that the organs could but imperfectly assimilate. The appearance of these unhappy victims of deficient nourishment was striking;—their bodies were horribly emaciated; their jaws hollow, and their physiognomy peculiar; the whole vitality of the individual seemed concentrated in the eye, which was unnaturally brilliant, with an enormously dilated pupil; and the look was fixed, and characterized by an interrogative astonishment, in which good-nature was mingled with fear. The movements of the body were slow; the walking halting, the hands trembling, and the voice feeble and bleating. The mind was no less notably affected; questions were answered slowly, and memory in the greater part almost extinct. When questioned as to the nature of their disease, these unfortunates all answered that they did not suffer except from hunger. The breath was fetid; the tongue narrow, pointed, oblong, and trembling, nearly always red at the tip, often aphthous, and constantly covered with a thick yellow coating. The epigastrium was shrunken, and seemed to stick to the vertebral column. The respiration was slow and sobbing. The pulse was either very quick, or remarkably slow, easily compressed, of astonishing smallness. All the secretions participated in the great alteration of the blood, which is their source, but it was especially the cutaneous transpiration which was modified. The skin was yellow, dry, and resembled parchment. Its pores secreted a viscous dust, which accumulated and concreted as a blackish, pulverulent crust, horribly fetid. This condition of the skin was at first attributed to uncleanliness; but in such of the sufferers as were sent to the hospital, baths were in vain tried to restore the natural appearance and function of the integuments; in an hour after complete cleansing, the skin would be again covered with this anormal secretion. On touching the skin the sensation was acrid and biting, and the hand for some time afterward was impregnated with a disagreeable odor." Such is a truthful picture of the effects of continued defective nourishment on the human being. And Chomel observes:—

"The prolonged use of a scanty regimen is a frequent cause of obstinate constipation and various digestive troubles, in those who fast throughout Lent," a fact annually verified in the writer's practice.—C.]

64. (4). *Excessive bodily exertion* of various kinds is a common exciting cause of disease. General muscular efforts, as in running, walking up hill, rowing, &c., hurry the movement of the blood back to the heart, and resist its distribution through the arteries in such a degree that the heart, the lungs, the brain, and other organs, have an unusual pressure of blood upon them (§ 51).

The heart, excited to inordinate action, is often strained and distended, and its function, or even its structure, and that of the great vessels, may be impaired in consequence. This is especially apt to happen if there

be anything already imperfect in the structure of the organ, its valves or vessels; and there are naturally very various degrees of perfection and strength in these parts.

The brain is particularly liable to suffer from violent exertion, especially if joined with a stooping or constrained posture; for its vessels are not, like those of the limbs and trunk, supported by muscular pressure upon them, and the excited heart can therefore send its blood into them with more force. Hence giddiness, noise in the ears, deafness, defective vision, convulsions, palsy, and apoplexy, have been brought on by violent exertion.

The lungs are also apt to suffer; for the blood being returned to them faster than they can arterialize it, they become greatly congested; hence cough, dyspnœa, hæmoptysis, or inflammation of the lungs, may ensue; and the texture of the lungs may also sustain injury in consequence of the violent strain to which it is subjected by the increased exertions for breath.

Other internal organs sometimes are disordered by the blood thrown or retained in their vessels by the pressure of external muscular action. Derangement of the liver, hæmatemesis, hæmorrhoids, and hæmaturia, have been brought on by such a cause. The sharp pains or stitches felt in the sides or abdomen, on running fast, are commonly supposed to be in the liver or spleen; but more probably they are spasms of the intestines—temporary colic, produced by irregular pressure on them, when their sensibility is raised by the blood unduly thrown into them.

Some kinds of muscular exertion peculiarly affect certain organs. Thus loud reading or speaking, or blowing wind instruments, especially tries the organs of respiration and the voice, and may cause hemorrhage, inflammation, and various diseases of these organs. Excessive or rough riding or leaping may injuriously affect the kidneys and organs of generation. Straining to lift a heavy weight, or at stool, or in any continued effort, which implies holding the breath, endangers the structure of the vessels of the chest and brain, on which there is no equally counteracting muscular pressure.

Bodily exertion, long continued, may also cause disease by its exhausting effects. In extreme degrees, this exhaustion may amount to syncope, and even death; short of this, it may cause great weakness of muscles and of the heart, with corresponding depression of other functions, with congestion of the viscera, defective assimilation and excretion; hence arises the low typhoid or adynamic fever which sometimes follows prolonged fatigue. In slighter cases, we have giddiness, faintness, nausea, loss of appetite, indigestion, costiveness, amenorrhœa, and other varieties of injured function. When exercise is carried on so long, or to such a degree, as to impair the organic functions, it thereby induces disorder in them in addition to the weakness, prostration, and actual suffering in the animal functions. A serious part of such disturbance is the sleeplessness which ensues from extreme fatigue, and which may bring the patient into a state resembling that of delirium tremens. This, as we have already mentioned under the head of predisposing causes (§ 23), is mainly due to the state of the respiration, which being insufficiently maintained by the weakened spinal function, is aided by continued vo-

luntary efforts, which are manifest in the frequent sighing that takes place. In this case, the best hypnotic will be found in a diffusable stimulant.

65. The opposite extreme, *want of exercise*, is capable of exciting as well as of predisposing to disease (§ 24). Thus internal congestions, deficient and disordered secretions, general plethora, over-nourishment of adipose texture, and wasting of muscles, and various evil consequences of these morbid conditions, may result from this cause when long in operation. When combined with some of the other disturbing influences noticed in this section, it is a still more ready and common cause of mischief. Some organs more particularly suffer from a sedentary mode of life; for example, the liver, from the increased task of decarbonization of the blood which deficient respiratory exercise throws on it; the brain, from its vicinity to the centre of the circulation, exposing it to an accumulation of blood when the distant circulation fails; hence bilious disorders, dyspepsia, hemorrhoids, headache, giddiness, &c.

66 (5). *Strong mental emotion* or *acute sensation*, is a common cause of disease. Closely knit together as the mind and body are, it is not surprising that they should ever be ready to affect each other, and that when the impression is strong, the affection should not be slight or transient. The heart most remarkably suffers from such causes. Thus a sudden shock, whether of grief, surprise, fear, or even joy, may cause fainting, partial suspension of the action of the heart; nay, even death has ensued; and the expressions "frightened to death," and "killed with joy," are not always mere figures of speech. Sudden acute pain often causes fainting. Palpitation and irregular action of the heart are very common effects of emotions.

Other parts also suffer from strong moral impressions. Spasmodic asthma and spasmodic affections of the throat are sometimes thus induced. Apoplexy, palsy, inflammation of the brain, epilepsy, and insanity, have been caused by excessive anger, terror, surprise, and joy.

Very commonly, mental emotions affect the secreting organs, and especially the functions of the alimentary canal. A piece of very bad news takes away appetite, or impairs digestion. Fright or anxiety often loosens the bowels, or brings on a bilious attack, or jaundice. The uterine periodic function is remarkably subject to the influence of moral emotions, and many of its disorders may often be traced to this source.

The slower emotions of the mind and over-exertion of its faculties are also exciting causes of disease. Long-continued depression or anxiety sometimes induces dyspepsia, costiveness, or diarrhœa, asthma, and functional disorders of the heart, menorrhagia, and dysmenorrhœa; and in time, structural diseases of the same parts occasionally follow these functional affections. Over-exertion of the faculties, or excitement of the passions of the mind, is chiefly felt in its own functions, or in its own organ, the nervous system. Hence may arise congestions of the brain and exhaustion of nervous power, with giddiness, stupor, headache, dull and disordered sensation, and even apoplexy and palsy. Or the disease may be inflammatory, with symptoms of irregular excitement, nervousness, delirium, tremor, convulsion, partial paralysis, &c. Sometimes the

effects of excessive mental exertion or moral emotion are apparent only in the phenomena of the mind, the powers of which are injured or disordered, and various forms of insanity are produced. When we consider the variety and amount of food and condiment, employment and excitement, that pass into the minds of persons in the busy and worrying scene of civilized life, it is not extraordinary that the mind, as well as the digestion or other function, should occasionally be disordered by such causes.

67 (6). *Excessive evacuation* or *loss* either of blood or of some secretion, was formerly noticed (§ 28) as a cause of debility, which predisposes to other diseases; but if the loss be great or sudden, it may produce immediate disease. A certain fulness of the heart and bloodvessels is required for their healthy functions, as well as for those of all the organs which they supply. If a moderate quantity of blood be suddenly withdrawn, or a large quantity less suddenly, the heart's action will be impaired, rendered irregular, and may be interrupted, and the brain not receiving a current sufficient to maintain its functions, there may be fainting, with loss of consciousness, accompanied or followed by disordered function, palpitation, delirium, convulsion, or by death. The sudden impression in these cases is evidenced more on the brain than on the heart; for these effects may be induced by the loss of a much smaller quantity of blood in an erect or sitting posture than in a horizontal posture. Similar results have been found to ensue from the sudden removal of pressure from the vessels in any considerable part of the body, as by the discharge of the fluid of ascites, or by inclosing a limb in an exhausting tube. (Dr. Arnott.) Lower mentions a case of extensive varix (enlargement) of the veins of the lower extremities, in which the patient could not stand without fainting, until the legs were bandaged. In these cases, much of the blood, although not removed from the system, gravitates into vessels, where it becomes unavailable for the general circulation. The fainting which occurs in these cases is called *cerebral syncope*, because the functions of the brain are suspended, consciousness is lost before the heart's action is interrupted; but the disorder of the brain reacts on the heart, and adds another influence to impair its action also. This is Dr. Alison's explanation. On the other hand, if the hemorrhage is gradual, and the posture horizontal, other functions fail before the consciousness is lost—the chief symptoms being "feebleness of muscular action; paleness and collapse of the countenance; coldness, beginning at the extremities; cold sweat, beginning on the face; the pulse imperceptible," and the heart's action becoming so. The true nature of these effects, and the reaction and nervous symptoms with which they are often followed, will be considered hereafter in connection with the subject of anæmia.

Not only bloodletting, but other evacuations, purging, sweating, and vomiting, the catamenial and seminal[1] discharges in excess, are capable

[1] [A man who, during his whole life, has exposed himself with impunity to the inclemencies of weather, is attacked with rheumatism, when exposed after excessive venereal indulgence. Under similar circumstances, the same disposition to attacks of yellow fever was noticed at St. Domingo; and Diemerbroeck remarked at Nymegen, that all who married during the continuance of the plague, were attacked with the disease soon afterwards. (Chomel).—C].

of producing syncope and general debility. The depression and faintness induced by these, although less prompt, are often more permanent than those from bloodletting; for such evacuations imply, not only reduction in the mass of blood, but also an exhaustion of the vital energies in the secretions and functions concerned in producing them.

The diseases gradually induced by these several causes of evacuation, are seldom of a simple kind. General weakness of the muscles and functions is commonly a result; but this is often complicated by symptoms of partial reaction, palpitation, spasms, noises in the head, images in the sight, pains in different parts, sometimes very acute, but seldom long fixed, partial paralysis, and a defective and disordered state of the excretions.

68 (7). *Deficient evacuation* of excrementitious matter, whether natural or accidental, is a very fertile source of disease. The operation of this class is somewhat diversified, some causing disease by the positively noxious influence of matter retained in the system, which is the case of the excretions of urine and feces; others, by causing fulness of the vessels, and the various disorders which this may induce. To the latter cases belong sudden suppression of hemorrhages, or other discharges which have become habitual.

The matter of alvine and renal excretions is essentially pernicious, and cannot be long retained even in their natural repositories without causing mischief. Feculent matter, when it has reached the large intestine, is still acted on by the absorbents, which take up its more fluid parts, and with them, if long retained, fetid matter, which ought to be excreted. The solid residue becomes hard and scybalous, and may remain lodged in the cells of the colon, a cause of irritation, distension, and obstruction (§ 51). Sometimes the system suffers before the intestine itself; at length, however, or sometimes at first, this part becomes irritated; colic, diarrhœa, and inflammation may ensue—nay, in some instances, where efficient remedies are neglected, even ulceration and other structural changes take place, before the offending matter is dislodged.

The retention of urine has even more serious effects. Besides mechanical distension, irritation, and rupture, which may follow from the constantly accumulating secretion (§ 51), the fluid is partially reabsorbed, giving a urinous smell to the breath and perspiration, and sometimes causing typhoid symptoms, which in extreme cases prove fatal, with delirium or convulsions, and coma; and effusions of serum, containing urea, are found in the brain, chest, and other parts. These are effects more commonly of suppression than of mere retention; but, in fact, suppression often follows retention; the retained urine is prone to decomposition (§ 53); highly irritating and offensive matters are produced, which cause injury to the bladder, rapidly extending up the ureters to the kidneys, whose function then becomes impaired or suppressed. In several cases of the early stage of the severest form of Bright's disease, in which the urine was very scantily secreted and highly albuminous, I have seen typhoid symptoms of the worst character ensue, accompanied by a breaking up and partial solution of the color-

ing matter of the blood, with the appearance of pus globules in it; in two instances, there was effusion of a bloody purulent fluid into the joints a day or two before death; these results will be further noticed under the head of defective excretion and purification of the blood as an element of disease. Checked perspiration is a well-recognized cause of disease, commonly of a febrile or inflammatory nature; but the sudden suppression of a fetid sweat in the feet, axillæ, &c., has sometimes been followed by such serious disturbance of the health, as plainly indicates that the matter thus excreted is of a noxious quality.

The preceding are extreme results; but the attentive observer will find that smaller degrees of the same causes, insufficient secretion, or insufficient evacuation of excrementitious matters, are among the commonest sources of disorder; and it is by a proper restoration of these functions that the almost universal domestic remedies, as well as the common pills and draughts of the surgery, prove so useful in preventing as well as in removing disease. We shall have many occasions to illustrate these facts.

Numberless maladies arise from suppression or irregularity of the catamenial discharge, which appears to be a highly carbonized blood, and therefore its excretion gives relief. Diseases are not unfrequently excited or rendered active at the period of its total cessation. The same may be said of the secretion of milk. The disorders which these first produce are commonly connected with local or general plethora; but eventually the quality of the blood in the body becomes altered as these excrementitious matters are suppressed.

69. An artificial or diseased discharge or secretion, as that of a seton or issue, or from an ulcer or diseased membrane, or an unnaturally profuse flow of an ordinary secretion—such as looseness of the bowels, if so long established as to have become habitual—cannot be suddenly suppressed without great risk of exciting disease. In the case of habitual puriform or sanious discharges from setons, issues, and old sores, their sudden suppression has sometimes given rise to the most formidable symptoms, showing that a noxious matter had been thrown back upon the system; and the fear of such accidental suppression, which cannot be always prevented, deters me from frequently employing these artificial drains in the treatment of disease. Habitual hemorrhages, as from the nose or rectum, and the practice of periodical bloodletting, cannot be abruptly checked with safety. The maladies which result will vary with the predisposition; but generally they are of the nature of local or general vascular fulness, or some disorder of secretion, or of the nervous system, arising from disturbances in the circulation. As examples, may be named—congestion of the brain, apoplexy, congestion of the liver, various hemorrhages and inflammations, gout, epilepsy, palsy, hysteria, hypochondriasis, mania, &c.

The suppression or too rapid removal of some cutaneous eruptions may be appended to this class. The diseases which it excites are sometimes inflammatory or profluvial, as gout, rheumatism, diarrhœa, &c.; sometimes more nervous, as chorea, epilepsy, asthma, dyspepsia, hysteria, &c.

70 (8). *Defective cleanliness, ventilation, and drainage.*—Much of the pernicious influence exercised by these causes might be referred to the last head; for there are few kinds of filth more offensive, few mephitic gases more foul, and few descriptions of offal more abominable than those that are excreted from the animal body itself. And if, as we have seen, such matters are so injurious when not sufficiently eliminated out of the body, it is not surprising that they continue to be noxious, and may become causes of disease after they have been evacuated, if proper means be not taken to remove them. The necessity of self-purification is illustrated by the instinctive habits of many animals and birds, which take much pains to cleanse themselves and their young, and in many instances, carefully remove excrements from their nests and habitations. Even plants are supposed by some botanists to exhibit a like provision for preservation against self-poisoning, in the constant spreading of their roots into new soil, uncontaminated by their own excreted matter. Yet, with strange disregard of all instinctive feelings, and indolent neglect of the plainest dictates of reason, human beings are found continually exposing themselves to the influence of their own accumulated filth, until disease is engendered and aggravated into pestilence, and the rate of mortality is doubled or tripled in the population.[1]

Although the three particulars, neglect of cleanliness, imperfect ventilation, and defective drainage, operate much in the same ways, and are very commonly combined, yet, with a view to suggest remedial means, it will be useful to consider briefly the modes in which each is known to excite disease.

71 (*a*). *Filth accumulated on the surface*, consists of the inspissated matter of perspiration, together with any extraneous dust or dirt to which the individual may be exposed. The sweat is peculiarly rank and offensive in some persons, especially when accumulated during much muscular exertion; and in some parts, as in the axillæ, and perineum, and between the toes, is combined with an odorous principle, the disgusting character of which seems to be intended by nature to suggest the necessity of frequent ablutions; yet how many, and these not confined to the lowest ranks, are "content to live in dirt and stink," and often eventually to pay the penalty of their filthiness in various cutaneous diseases which are thereby induced! In young children, in females, and in many aged persons, the urine dispersed in the vicinity of the secreting orifice becomes an additional cause of irritation and offence.

[1] Every practitioner of experience has encountered many proofs of the potency of these causes, in generating and aggravating disease; and the profession and public have a most valuable collection of evidence on this point, in the following official Reports:—

Report from the Poor Law Commissioners on the Sanitary Condition of the Laboring Classes. 1842. By E. Chadwick, Esq.

Supplementary Report of the Practice of Interment in Towns. 1843. By E. Chadwick, Esq.

First Report of Commissioners on the State of Large Towns and Populous Districts. 2 vols. 1844.

Second Report of ditto. 2 vols. 1845.

A brief but comprehensive abstract of these Reports may be found in a small pamphlet, entitled *Letters on the Unhealthy Condition of the Lower Class of Dwellings*, &c., by the Rev. Charles Girdlestone. 1845. Longman and Co.

The accumulation of filth on the surface farther favors the propagation of vermin and of contagious diseases, especially the itch, from which few of the "mighty unwashed," are totally free. It also impedes free perspiration, and thus favors the production of rheumatism and diseases of the urinary organs, and others which sympathize with the skin. Neglect of cleanliness in clothes and dwellings, if not equally injurious by direct contact with the body, becomes hurtful by contaminating the air.

[Mortality is invariably commensurate with the filth and destitution of the inhabitants, and the impurity of their abodes.—C.]

72 (*b*). *Defective ventilation*, or insufficient change of the air of dwellings, might be considered to readily suggest its proper remedy by the feeling of suffocation induced; but it is not such a deficiency of oxygen, or excess of carbonic acid, as induces a stifling sensation, that does most harm; it is rather the scanty supply of fresh air that stints the vital processes without suddenly disturbing them; and the gradual accumulation of foul effluvia that slowly poisons, without exciting alarm. Persons are gradually brought to endure without complaint the impure air of a close room, which, to any one entering it from the open atmosphere, seems quite suffocating. Thus, in the habitations of the poor, especially in densely populated towns, it is not rare to find ten or fifteen crowded together in one small room, without any other supply of air than that which comes through chinks of the floor or window, or when the door is accidentally open. Among this class, the dread of cold prevails much more than the desire for fresh air; and except in the height of summer, the solitary window may be rarely opened; and during the night, when the greatest number are collected together, every opening is kept carefully closed. During the winter, the same plan is pursued; but then, if there be any fire in the hearth, it will insure a greater amount of ventilation.

[A powerful exciting cause of disease is the respiration of air charged with exhalations from the pulmonary and cutaneous surfaces; by which means the oxidizing depuratory processes are interfered with, and an accumulation of putrescent matter in the system takes place. It contributes to the propagation of the so-called zymotic diseases in a great degree. The cholera epidemic in England, in the autumn of 1849, abounded in proofs of this statement, as will be seen on reference to the late "Report of the General Board of Health." A striking illustration of the effects of *over-crowding* took place in the town of Taunton, in England, towards the close of the epidemic in 1849. This, a town of 16,000 inhabitants, with the exception of a good deal of diarrhœa, had remained tolerably exempt. Suddenly, a violent attack of the pestilence took place in the workhouse. In the course of one week, out of 276 inmates, 60, or nearly 22 per cent. were swept away. Now, what was the condition of the workhouse? It is described by Dr. Sutherland as being low, badly drained, and badly ventilated; there were numerous nuisances within the walls, and the inmates had insufficient space allowed them, and personal cleanliness was neglected. The medical attendant had, previous to the invasion of the epidemic, called the attention of the Board of

Guardians to the defective arrangements of the house. "It is very subject," he said, "to measles, scarlet fever, typhus, dysentery, and scurvy." He complained of the closeness and offensiveness of the wards at night, and considered that the space allowed each inmate was not above two-thirds of what was requisite for safety. But the stress of the disease fell upon the girls' school-room. Out of 67, one-half were attacked, and as many as 25 died. Dr. Sutherland tells us, that "the greatest degree of overcrowding existed in the girls' school-room. In this miserable place were huddled together 67 children, with about 68 cubic feet of air to each. Whilst the pestilence was raging in the workhouse, whilst no actual case occurred in the town, it is a remarkable and instructive fact, that not a *solitary case of even diarrhœa occurred in the jail.* Each cell contained from 800 to 900 cubic feet and upwards of air, besides being systematically ventilated and warmed to maintain an even temperature during the twenty-four hours, and attention to personal cleanliness was strictly enforced. Few opportunities occur, well remarks Dr. Sutherland, such as those afforded by the instance before us, of testing the truth of the principles of preventive science.

There exist numerous other emphatic observations on the effects of overcrowding, in exciting a virulent development of the choleraic poison during the epidemic in England in 1849, and the writings of the East India practitioners abound with interesting examples. Mr. Kellie, one of the most intelligent and experienced of them, says:—

"The disease commits its greatest ravages in crowded, ill-ventilated barracks, bazaars, densely populated towns—particularly those surrounded by walls—crowded school-rooms, native huts, into which there is but one opening, and that closed at night. Whole families are sometimes swept away from exposure to this exciting cause." The same writer says, that "at Juggernaut it is an annual visitant. The town of Pooree contains 35,000 inhabitants, and the number of pilgrims sometimes amounts to 150,000. The inhabitants are usually quite healthy before the occurrence of the festival, which takes place in June or July. But immediately on the arrival of the pilgrims, and when the lodging-houses are literally crammed with inmates, cholera suddenly breaks out, and in the space of a few days hundreds are cut off. This, he adds, is not an occasional or incidental occurrence; it is an invariable one; and the disease which has thus been generated, as suddenly disappears on the dispersion of the crowd." Similar testimony is adduced by Mr. Thorn, in his account of the dreadful outburst of cholera at Kurrachee, in the summer of 1846. Another singular and striking example of the effects of overcrowding, and showing their dependence upon a very slight change of circumstances, has been furnished by the late Baron Dupuytren. The usual number of patients in his ward in the Hôtel Dieu at Paris, was two hundred, and then there was no unpleasant odor, nor any sign of infectious disease; but no sooner had the number increased to two hundred and twenty or more, than a peculiar fetor became apparent, and many of the patients fell victims to hospital gangrene and adynamic fevers.

It was found during the cholera epidemic of 1849, in England, that

the spots where fever was most common were precisely those where the cholera visitation was most general and severe; the latter appearing not only in the same streets and the same houses, but even in the same rooms which had been visited by typhus.[1]—C.]

The habitual want of pure air especially exercises an unfavorable influence on the state of the blood, and the functions of circulation and nutrition, causing pallidity of the surface, poorness of blood, imperfect development of the fibrous principle, which, instead of contributing to the nourishment of the muscles, degenerates into scrofulous or tuberculous matter, the deposition of which in the internal organs or glands is favored by the weakness of the circulation. Exercise may in some degree counteract this effect of impure air; thus Dr. Guy found that in the close workshops of a printing establishment, the compositors, whose employment requires no exertion, fall victims to phthisis in the proportion of 44 to 31½ per cent. of the pressmen, who, while breathing the same air, use active bodily efforts. This difference is quite intelligible when it is remembered that active exercise, by increasing and extending the force of the circulation, tends to remove congestions, to promote excretion, and by the activity of the respiratory function, enlivens and purifies the condition of the blood. Similar exercise in pure air would have much more salutary effects, the deaths from the same cause in out-door laborers not exceeding 25 per cent.

Insufficient ventilation is by no means confined to the dwellings of the poor. In modern days, when workmanship of houses is more complete than it was in olden times, there are no longer the latticed casements, chinky floors, ill-fitted doors, and above all the roaring pile in the spacious hearth, that supplied abundant ventilation to the houses of our forefathers. Now, in proportion as houses are "well-built," every crevice is so thoroughly stopped, that our rooms, when closed, are wellnigh air-tight, and their occupiers are inclosed in an atmosphere which is deteriorating in proportion to the number assembled. Add to this the vitiating effect of artificial lights, and of fires, the smoke of which may not freely escape for want of a due supply of air, and it will appear how modern houses often comprise the conditions calculated to produce this cause of disease. In public offices, schools, hospitals, churches, chapels, theatres, and other places where great numbers are collected together, the cause is still more fully in operation; and it is quite certain that not only is the public health much injured thereby, but much of the useful or agreeable objects of such assemblies is defeated through the discomfort produced by the closeness and foulness of the air.

[1] [Whilst these pages are passing through the press, another very strong and incontestable instance of the effects of overcrowding in the production of epidemic disease, has been presented. During the months of January, February, and March, 1853, Typhoid Fever has prevailed to a great and alarming extent in Paris. A late number of the *Gazette des Hôpitaux* thus accounts for this sudden and severe visitation: In the latter part of the year there was a large arrival in the capital, of work-people; from the demolition of several of the most densely populated quarters inhabited by this class, on account of the improvements, they accumulated in other parts of the city. Work became suddenly interrupted on the occurrence of the severe weather; and the dwellings of the laborers, which were dirty and ill-ventilated, became over-crowded; and more than two-thirds, perhaps three-fourths of those attacked, lived in these lodging-houses (*garnis*).—C.]

The ill effects of deficient ventilation are increased by heat and moisture; the former operating not only by increasing the animal exhalations, but also by rarefying the air, and thus reducing the amount of oxygen in a given bulk; moisture probably acts in a degree in like manner, but also, as I conceive, by removing the difference between the air respired and that in the lungs which promotes that diffusion or interpenetration of gases on which the access of oxygen to the vesicular structure of the lungs depends. For, be it remembered, the air taken in at each inspiration, is not enough to reach far in the tubes; its transfer into the air-cells is accomplished by the law of diffusion of gases, which operates in proportion to the dissimilarity between the gases, and difference in amount of contained watery vapor must exemplify this law.

In certain occupations, gases or vapors of a positively noxious quality are engendered, and augment the evils of deficient ventilation. Such is the case in many chemical works, slaughter-houses, and dissecting-rooms, soap, glue, and cat-gut manufactories, and in the employments in which materials are used containing mercury, white lead and arsenic (§ 53). The deleterious operation of effluvia arising under these circumstances, may be short of a directly poisonous effect, yet, by adding to the unwholesomeness of the atmosphere, it gradually undermines the health, and is best to be counteracted by a more efficient means of ventilation.

73 (*c*). *Defective drainage* comprises much of the influences exercised by the preceding causes, filth and foul air; but it includes also circumstances that may exceed them in pernicious operation. The soil, which drains from habitations, contains, in addition to excrement, dirty water, washings and remnants of animal and vegetable matters used as food, and other offal; and all these, when mixed and stagnant, constitute the corrupting slough retained in cesspools and privies, and carried into sewers. The stench which these exhale, when opened, gives some idea of their deleterious influence; and the fearfully poisonous nature of the gases which they emit, has been proved by the sudden faintness and sickness, nausea, vomiting, and diarrhœa, which have attacked persons engaged in emptying them. Instances have occurred of individuals being speedily asphyxiated by the gases of cesspools; and where the result is not immediately fatal, a congestive or typhoid pneumonia ensued, which passed into gangrene in the first stage. (Chomel.) The precise nature of the gases evolved is not fully ascertained; but they obviously contain much sulphuretted and carburetted hydrogen, which, although known to be highly noxious, probably do not comprise the most deleterious part of these offensive effluvia. It is no wonder, then, that every ill-drained house should have a Pandora's box, ready to pour forth its evils whenever occasion offers; and always oozing them out in degrees sufficient to impair the health of the inhabitants, and gradually to excite cachectic and other chronic diseases. Hence, as it appears in the several sanitary reports before cited, the mortality rises in a remarkable proportion in all those districts of towns where sewerage is absent or inefficient. The worst nuisance of this description is

the cesspool without a drain from it; unemptied for months or years, and often imperfectly covered, it continually poisons both air and water; and typhoid fever, diarrhœa, cholera, dysentery, dyspepsia, inappetency, and general weakness and mal-nutrition, are results of different degrees of its pestiferous operation. Scarcely less injurious, and more insidious in its operation, because the effluvium is less offensive, is the untrapped drain in connection with the sewers of large towns. This cause of disease exists extensively in London, not only in the street drains, which are always open and emitting the gases of the sewer, the bad odor of which is perceptible in certain winds, but also in the drains of houses which are either intentionally or negligently left open, or are not air-tight from the absence of water in the traps. Nothing is more common than to perceive the peculiar smell of the drain on entering a house, and in many instances I have found that this has proceeded from the trap left open, or dried up, and therefore inoperative, and requiring only the simplest expedient to stop the evil. When a single trap is open in a house, especially in the winter, when doors and windows are closed, and there is no adequate supply of air for the fires in the house, the foul air is drawn up from the sewer in a strong current, and quickly pervades the house from bottom to top, carrying with it a pernicious influence. It is surprising how ignorant servants and employers and even professional men, are on this point, which so immediately concerns their health and comfort; and I have visited in many houses where this has seemed to be a cause of illness or impeded convalescence, in low nervous fevers, bowel complaints, influenza, neuralgia, headaches, and other ailments. In some instances, the leakage may be in consequence of the inroads of rats, or the displacement of the brickwork of the drains. It may be useful to state that, besides by the smell, which is not obvious to every one, the effluvia of drains may be detected by the darkening of white paint, and the early spoiling of meat in the lower basement story of the house.

74 (9). [The influence of seasons in predisposing to and exciting disease is much the same as that of temperature. From the accurate and valuable statistics of the Registrar-General of Great Britain, it appears that the greatest number of deaths occurs in winter, next in spring, then autumn, and finally summer; and from the imperfect statistics of several of our States, the mortality would appear, especially as far as the Northern States are concerned, to follow the same rule. Diseases in the spring are said to be more acute, their symptoms to be better defined, their course more speedily run, their treatment more amenable, and their liability to relapse less. Autumnal disorders are more insidious in their origin, more irregular in form, more protracted, less readily cured, and very subject to relapse. At this season all diseases of malarious origin prevail in warm climates; and in more temperate countries, disorders of the digestive system are common;—excited by the violent and sudden alterations of temperature, between day and night, and the imprudent and immoderate use of fruit.—C.] Of all the exciting causes of disease, there is none so common as *temperature* in extremes, or in sudden transitions; cold, heat, and sudden transitions from cold to hot, or hot to

cold. Both heat and cold have different modes of operation, and cause disease in different ways.

Extreme heat and extreme cold are directly destructive to life. Heat above 180° coagulates the albumen of the blood, and thus obstructs the bloodvessels, and may cause other chemical changes of a disorganizing nature (§ 53); a part that has been raised to this temperature, therefore, necessarily dies; it cannot live again. It is true that we occasionally see boiling water at 212°, boiling oil at 600°, and redhot iron at 1000°, produce no other effect than violent inflammation and blistering of a part; but that is because these bodies have been applied for too short a time to do more than violently stimulate the part, not time enough to raise it to the decomposing temperature; a few seconds more, and the part would be killed.

Cold below 32° freezes the water of the fluids; and as it destroys the life of tender plants, so it kills parts of animals, whether by the expansion of the ice injuring the delicate organization (Sir B. Brodie), or whether from the mere stoppage of the circulation, or other cause, is unknown. The part may be afterwards separated from the living parts by a vital process of inflammation and sloughing.

75. A disorganizing degree of heat, extensively applied, acts like a violent mechanical injury—such as tearing off or crushing a limb (§ 52). It directly depresses all the functions; the pulse becomes very weak, frequent, and sometimes irregular; the muscular strength almost annihilated, and consciousness may be nearly or quite suspended. In this state, notwithstanding the stimulant properties of heat, and the inflammation which it generally excites, patients require stimulants, and they often die in a state of complete collapse, without any rallying or reaction. Extreme cold, also, if for some time applied to the whole body, depresses and paralyzes all its powers, even that of generating heat, and, therefore, of resisting cold. Sir Astley Cooper observed, that on plunging kittens into ice-cold water, the arterial blood did not become venous in the veins; and Chossat found, in animals killed by cold, arterial blood in the left cavities of the heart. From a similar cause, the limbs become benumbed by extreme or continued cold; thus persons are drowned in cold weather much more speedily than in warm. With less intense degrees of cold, on the other hand, which do not destroy the vital processes, more oxygen is absorbed, more carbonic acid formed, and heat generated, which are the means by which animals resist cold.

76. Heat which is insufficient to decompose, is directly stimulant. It excites the function of parts, and when generally applied, induces a state of fever. Thus when a person is in a vapor-bath, or hot-air bath, the pulse quickens, the whole surface becomes red, full, and hot; there may be throbbing and pain in the temples, and a feeling of feverish oppression, until a sweat breaks out, which relieves the superficial tension and fulness, and soon reduces the increased heat. Similar results may ensue from confinement in overheated rooms; and if there be any tendency to local congestion or inflammation, particularly in the head, this excitement may be enough to produce it. The continuance of heat enervates, reduces the strength and appetite, and may excite a feverish state, with disorder of the liver. The oppressed breathing which is often felt in

heated rooms may, according to the view of Liebig, be ascribed to the smaller amount of oxygen in the air rarefied by the heat; but it is probable that this is not the only cause.

A more partial exposure of the body to heat may produce still more disordering effects, if the part overheated be capable of suffering from the excitement. Thus solar or artificial heat to the head may cause severe headache, apoplexy, or inflammation of the brain. Heat to the spine, as on sitting with the back near a large fire, is very apt to cause sickness and faintness, and, if continued, may induce convulsions. More local inflammations, as of the eye, ear, and skin, are frequently caused by exposure of the parts to heat. Gout may sometimes be excited in the feet by the same stimulus, and this is often attempted purposely.

77. Cold, on the other hand, is directly sedative. It contracts tissues and vessels, especially the arteries, and thus at first renders parts pale and shrunk. In persons of feeble circulation, after bathing, the fingers are sometimes quite bloodless and numb from this cause; the cold having quite closed up the arteries.[1] But cold also retards the passage of the blood in the capillaries; the viscidity of the liquor sanguinis seems to be increased; globules stick to the sides, or move but slowly, and the part soon becomes purple or blue, from the congestion of blood in it. This purple color is chiefly seen in parts much exposed, and where the blood habitually enters with freedom, as the cheeks, ears, nose, and hands. There is also much internal congestion from the intropulsive operation of the cold—that is, the external parts being constricted and obstructed, blood accumulates more in internal parts, and the heart's force is more expended on these. This may in part account for the degree of stupor and ultimate insensibility into which persons exposed to extreme cold are apt to fall. In some such cases, there has been a flow of blood from the nostrils or ears; the stupor has continued for hours after the heat and circulation have been restored; and, in fatal cases, much serous effusion has been found in the brain.[2]

78. Hitherto, we have considered the *immediate operation* of cold (§§ 74, 77). But its indirect effects are more commonly known: these are, reaction, irritation, inflammation, and their consequences; and they will be more manifest where the cold has been partial, and the strength of the circulation generally not reduced. Thus, after a part has been exposed to severe cold, when restored to warmth, it becomes the seat of increased flow of blood, which causes redness, pain, and more heat; and various forms of inflammation may ensue, generally modified by the specific effect which the previous cold has exercised on the vessels and nerves; varying also with the strength of the general circulation. Thus, as the indirect effects of cold in a part, we may have chilblain, gangrenous or erysipelatous inflammation, and paralysis, or altered sensation.

[1] A similar effect may be seen under the microscope, on applying ice-cold water to the frog's web; the arteries contract to obliteration. This is contrary to the assertion of Poiseuille. (See my Gulstonian Lectures, *Med. Gaz.* July 16, 1841, p. 639.) It must be remarked, that the elementary action of cold on the arteries is strictly stimulant, exciting their vital property of contraction; but its operation on textures and organs is sedative, because it impairs the circulation which supports their functions. So, too, we have found that, where it reaches the heart, it paralyzes its powers (§ 74).

[2] Kellie, Ed. Med. Journal, vol. i. p. 304, quoted by Dr. Alison.

As much of the disease in these partial effects of cold, arises from the violence of the reaction and inflammation, and this depends on the sudden return of heat and circulation in the part, it becomes an obvious indication, for frost-bitten limbs, to retard this return by cold applications. But Dr. Alison well remarks, that this precaution is not needed, where the sedative effects of cold have been more general; here warmth and stimulants may be used freely, for there is no fear of partial injurious reaction.

79. We have hitherto chiefly considered the manner in which cold causes disorder in the parts to which it is applied; but this is not the most common mode in which cold excites disease. A person gets his feet wet, stands in a draught of cold air, or is exposed to cold when insufficiently clothed; he afterwards becomes diseased—not in the feet, or the parts chilled, but in some *internal* part. He gets a sore throat, a "cold in the head" or chest, an inflammation of the lungs, a rheumatism in the limbs, a looseness of the bowels, a catarrh of the bladder, or any other disease to which he may be predisposed (§ 14). Now how does the *external* cold cause internal disease? How is the effect transferred from external to internal parts?

Dr. Alison supposes that the cold operates chiefly on the nerves, and that the sensation which it excites is conveyed also by the nerves to the internal organs, where its morbid effects become manifest. But it must be objected that the morbific effects of cold are by no means proportioned to the sensation, or known nervous impression, which it excites. A person may have his limbs aching and benumbed with general cold; yet internal disease does not result. But if he has been exerting himself, is perspiring, and then gets his feet wet, or is otherwise exposed to cold, especially partial, without continuing his exercise, although he may scarcely *feel* the cold, yet he will be pretty sure to *catch* cold, and to exhibit some one or other of its internal morbid effects.

It would seem more probable, therefore, that external cold excites internal disease by deranging the circulation, particularly that in the capillaries. Cold checks the external secretion, the perspiration; it constricts and obstructs the vessels of the surface (§ 77), and must thus throw more blood inwardly, so that internal congestions are produced—these internal congestions impair the functions of the affected organs, especially those concerned in excretion (§ 68), and in other ways lay the foundation of disease. This intropulsive effect of cold will take place more readily, and to a greater extent, in proportion to the weakness or sluggishness of the capillary circulation. This may be weak naturally (§ 20); in this case, there is a constant liability to "take cold." Or it may be weak and relaxed from previous excitement, during fatigue (§§ 23, 24), or during sleep. Hence persons are more apt to catch cold after being in a hot room, after exertion, or when asleep. On the other hand, the injurious effect of cold is lessened or prevented by a vigorous state of the capillary circulation, whether that vigor be natural, or excited by continued exertion, stimulating drinks, or by febrile excitement (§ 17).

On this view, we can understand why partial, but continued cold, such as from draughts of cold air, wearing damp clothes, standing on cold stones, and the like, should be particularly injurious, even when the

sensation of cold excited is not great. Such causes of cold, acting long on the same part, more completely constrict its vessels, check its secretions; thus more surely injure the balance of the circulation, and by throwing a corresponding amount of congestion inwardly, fix it in some part predisposed to disease (§ 14).

When a person has thus taken cold, which he knows by general sensation of coldness and weak circulation, rather than by any feelings in the part chilled, powerful measures, which tend to restore the balance of the circulation, such as violent exertion, a hot or vapor bath, or stimulant drinks, may often yet prevent the further progress of disease. The general application of cold, if not long continued, is less injurious than that which is partial, both because it disturbs less the balance of the circulation, and because also it supplies the lungs with denser air, and therefore more oxygen; and its impression on the nerves of the face and chest excites more energetic respiratory movements, which maintain the heat and the vigor of the circulation. Healthy persons rarely take cold when travelling on the top of a coach, or in a perfectly open carriage, but they frequently suffer in a close carriage partially open.

80. Susceptibility to the morbid effects of cold is to be diminished by means which invigorate the capillary circulation, especially those which promote that process of reaction by which cold is naturally resisted. Now nothing tends to increase this more than sudden artificial applications of cold, as by cold bathing or sponging, followed by friction, exercise, heat, or stimulant applications, which promote the reaction (§ 16). The great art in usefully applying cold with these intentions, consists in using the cold in such manner and degree, and having the body in such a state before and after the application, that the reaction or glow, which is the sign of vigor in the capillary circulation, shall be most fully produced. If, on the other hand, the cold be applied too long, or when the body is exhausted by fatigue, exertion, or other cause (§ 20), or is naturally too weak, depressing effects of cold will continue; there will be little or no reaction, and the sensations of languor and chilliness show that the cold has been injurious instead of beneficial. The addition of salt to the water of baths, gives it a stimulant property which promotes reaction, and a similar influence results from the force or shock with which the water is applied. This shock excites deep and forcible respirations through an impression on the incident nerves; and these are probably the efficient cause of the process of reaction which follows.

The reaction which follows the judicious use of cold as a therapeutic agent, may prove serviceable, not only in resisting the farther influence of cold, but also to remove congestions and irregularities in the circulation from other causes, and to excite in the capillaries and secernents new actions, which may supersede those of disease. It is thus that the "water cure" of Preissnitz chiefly operates; and although too powerful an agent to be entrusted to unskilled and unscientific hands, it promises to become a valuable addition to the means of combating diseases, particularly of a chronic kind.

81. In the preceding remarks on cold, it must be borne in mind that the term cold is applied relatively, not absolutely; cold is not a fixed temperature or range of temperature; but something considerably below

the temperature of the body. Thus, a body that has been warmed throughout to a heat of 98°, and kept in an excited state by that temperature, would suffer from a draught of air at 70°, which would be cold to the body, and produce the physiological and pathological effects of cold. But if the body had not been previously warmed, so that the temperature of most parts of the surface might not exceed 85°, or if, although lately warmed, the energies of the body had not been exhausted by it, then air at 70° would feel pleasant, and produce none of the effects of cold. This is one of many facts which distinguish vital from physical properties. Physical or chemical properties are generally affected by fixed temperatures, independent of previous circumstances; but vital properties are variously affected through that power of adaptation by which they are enabled to maintain the same function in varying external circumstances.

It is thus that atmospheric changes in variable climates are fertile causes of disease. In this country, on a sudden change of wind, the temperature sometimes falls 15° or 20° in the course of a day, and without any peculiar exposure, the body may become so chilled by the change, as to suffer to a degree amounting to disease. Internal congestions are the common result, but the seat of congestion and disorder will vary according to the predisposition. Thus, after the heat of summer, the organs most apt to suffer are the liver and abdominal viscera, which are disposed to disorder by previous excitement (§ 25); on the other hand, in the spring after the winter cold, the lungs and air-passages are more prone to derangement (§ 26).

SECTION IV.

II. Non-cognizable Agents.

We now proceed to notice those causes of disease, the existence of which is inferred only from the fact that disease prevails under certain circumstances not well explained, unless we assume that causes do exist (§ 12), although we cannot prove their existence in any other way (§ 53). These comprise the *endemic*, *epidemic*, and *infectious* causes of disease. In the reports of the Registrar-General, they are termed *zymotic* (ζυμη, a ferment), but inasmuch as this epithet involves an hypothetical signification of their mode of action, it does not seem expedient to adopt it here.

I. ENDEMIC CAUSES.

82. Persons living in a marshy district are often afflicted by a disease called *ague*, which does not attack those inhabiting dry lands. Again, the inhabitants of certain deep valleys are often affected with the swelling in the neck called bronchocele, or goitre; the neighboring mountaineers are not so affected; and when those from below remove their

residence to the mountains, they often lose the disease. These are instances of diseases which may be said to dwell among the residents in particular spots; hence they are called *endemic*, *in* the people (εν δημος).

In some cases, much doubt still hangs over the precise source of endemic influence; some supposing it to be in the water, others in emanations from the soil; but this doubt does not apply to the cause of agues, intermittent and remittent fevers, which have been clearly traced to effluvia from marshes, jungles, rice grounds, &c. It has been found that when the wind blows across these marshes, the disease appears chiefly in persons residing to leeward of them, and not to windward; and it has been abundantly proved, that when the marshes are drained the ague ceases. From these and similar facts, it is concluded that the cause of the ague is an *effluvium*, *miasm*, *malaria*, or bad air; an *aerial poison*, which is supposed to be inhaled with the breath, and absorbed into the system.

83. The true nature of marsh malaria has not been determined. It has never been detected by chemical analysis. Professor Daniel conjectured that the malaria causing the destructive endemic fevers of Western Africa, might be sulphuretted hydrogen evolved from the sea-water by the decomposing vegetable matter brought down by the rivers; but I am informed by Dr. D. B. Reid, that experiments made in the late unfortunate expedition to the Niger, have negatived this notion. [Dr. D. Pereira Gardner reached the same conclusion as the late Prof. Daniel, as to the result of experiments on the air of malarious regions.[1] These views have been, however, entirely disproved by Drs. McWilliam[2] and Morris Pritchett, who have shown that free sulphuretted hydrogen does not exist in the waters of the Nile—the locality from which the water with which Prof. D. experimented was obtained; and that which was detected in the specimens sent to England and there examined, was generated on the passage, by the decomposition of the contents of the bottles.—C.] The microscope, rather than chemical analysis, may be expected to discover the nature of malaria.

Although hitherto unknown in its nature, some knowledge of the general properties of marsh malaria has been obtained through its morbific effects. It seems to be heavier than air; for persons occupying a ground floor suffer more than those living in upper apartments. Water seems to absorb or destroy it, for persons on board ship, or on an opposite side of a lake, are not affected; whilst at a greater distance, a favorable wind will convey the pernicious influence over land. A damp state of the air, however, favors its production; good fires in a house give marked protection to the inmates. It seems to be attracted by trees; for the vicinity of trees is doubly dangerous, whilst places beyond trees are more free from its effects than others at the same distance.

[Of the intimate nature and physical properties of marsh miasm, we know nothing. The vapors of the putrid waters of Fuentés, of the rice fields of Carolina and Lombardy, and of the Campagna, near Rome,

[1] [Am. Journ. Med. Sciences, April, 1843.]

[2] [Medical History of the Expedition to the Niger, &c. London, 1843.]

have been found identical in composition with the most salubrious air, on chemical analysis. But though ignorant of the active principle of paludal miasm we know many of the laws which govern its operation. It is in greatest concentration near the surface of the earth. We can trace its operation in a definite line of progress, and can observe it arrested by material impediments, as lines of buildings or trees. It has difficulty in crossing streams. Heat is its great evolver; moisture its chief vehicle. It differs from the animal or morbid poisons, in its longer periods of latency, and in the slowly progressive character of the functional and textural changes which it produces in the economy. It does not seem to possess those special affinities for certain textures, as shown by the morbid poisons; it confers no subsequent immunity; it does not multiply or reproduce itself in the system; nor are its effects capable of propagation from one person to another. That it is a material poison capable of effecting its entry in the blood is certain. It is soluble, for it may affect the fœtus in utero. (Simon.)—C.]

84. The chief points known with regard to the source of malaria, are, that it arises from the operation of the sun's heat on marshy ground, or on the banks or deltas of tideless rivers, after evaporation has proceeded to some extent; putrefaction of organic matter not being an essential part of the process.[1] The virulence of the malaria, as shown in the severity of the disease excited, and in the number which it affects, seems to bear some proportion to the heat which has led to its development. Thus the ague of this country, the pernicious intermittent of Italy, and the malignant intermittent of Western Africa and the West Indies, seem to arise from similar endemic causes, but differing in their virulence according to the degree of heat. A certain amount of moisture is, however, required; for a very dry season, which desiccates a marsh, stops the malaria; and the deposit of the evening dew always favors its production (§ 83). Again, excess of moisture checks its development, so that a very wet season, as well as a very dry one, may render a marsh less unhealthy (§ 83). Extreme heat will not, however, diminish the malaria from the banks of rivers, since portions of these are never dry. For a similar reason, all the low shores of the Mediterranean are always malarious at the commencement of hot weather; the absence of a tide preventing that frequent salt washing and drainage which purifies other European shores.

It is not only marshy or low grounds that engender malaria, although these are the situations commonly most favorable for its production. All that seems to be requisite is the continued operation of the sun's heat on moisture stagnant at or near the surface of the ground. I know instances in which ague has attacked persons living on a height of mountain limestone, forming a small table-land below greater heights. So also some swampy lands are not malarious, particularly peat bogs, which show a remarkable exemption from decomposition and effluvia of all kinds.

85. The morbid effects of marsh miasms are several; intermittent and

[1] Chisholm and Ferguson, Ed. Med. and Surg. Journ. vol. vi.; Trans. Roy. Soc. Edin. vol. ix.

remittent fevers of various types are the most remarkable of these, and they particularly affect the new residents; but the older inhabitants suffer from diseases of the liver and spleen, nervous affections, rheumatisms, dropsy, and cachectic complaints, and are generally short-lived. The first operation of malarious poison seems to be on the quality and distribution of the blood, which in the worst cases becomes speedily darker in color and otherwise altered, and accumulates to an extraordinary amount in internal organs, where it suffers still further from its stagnation and want of purification by the ordinary excretions. The fit of an ague is the reaction (§ 16) of the vital powers against this decomposing and cumulative influence of the poison on the blood; and if the vital powers are strong, and the dose of the poison not overwhelming, the fit successfully removes the internal congestions, and partially restores the purity of the blood by an increase of the excretions; but the poison, being still in the system, reproduces similar effects after a longer or shorter interval.

One of the most remarkable characters in the disease resulting from malaria, is the periodicity of their attacks, and the diminution or cessation of the symptoms in the interval. This is probably due to the alternate accumulation of the malarious influence in the body and the reaction of the vital powers against it.

86. There can be little doubt that there are different kinds of malaria besides that which causes intermittent and remittent fever (§§ 80, 81). Thus yellow fever and plague are endemic diseases, probably arising from aerial poisons. The propagation and mortality of the latter, perhaps its very existence, are very much to be ascribed to the filth and impurities of the towns where it prevails. These are cognizable causes, the operation of which in exciting and predisposing to disease has been already noticed (§§ 70–73, § 22).

Some other epidemic diseases can be traced to other cognizable causes; as the Guinea-worm, to drinking water containing its ova; the pellagra of northern Italy, and the plica of Poland, to neglect of cleanliness, and unhealthy modes of living.

II. EPIDEMIC CAUSES.

87. There is another class of diseases, which, in their affecting many persons in the same place and at the same time, resemble the endemic (§ 81). But they differ in this respect, that they do not regularly return at stated seasons (§ 84), nor are they confined to particular localities (§ 82), although they infest some more than others; but they attack a whole district, a whole country—nay, almost a whole hemisphere—within a very short time; often coming on without obvious cause; prevailing for some time, then disappearing for an uncertain period; perhaps recurring within a few months, or years, or not within the memory of man. These are called epidemics (επιδημος), like a blight or pernicious influence blowing *on the people;* and therefore affecting a whole country at once.

88. The cause of these diseases is supposed to be something in the

atmosphere; because the atmosphere is the only thing common to all the places so affected; but the nature of the cause is not known. It is true that some diseases, which seem to prevail epidemically, may be traced to the cognizable qualities, cold, heat, dryness, and moisture of the air (§ 74, *et seq.*). Thus diseases excited by cold sometimes prevail, like an epidemic, in the winter; those by heat, in the summer; catarrhs and quinsies abound in cold damp weather; croup and rheumatism become common during the prevalence of a cold east wind, in the spring; diarrhœa and dysentery are rife in the fruit season of the autumn. Others, again, such as dysenteries, fevers, scurvies, &c., have in some instances obviously arisen from deficient or contaminated food, bad water, or some distinctly cognizable cause (§§ 60, 70, *et seq.*). And as these causes belong to the class of cognizable agents before noticed (§ 52, *et seq.*), it is unnecessary to advert to them here. [The influence of local agencies on the development and virulence of contagious disorders is universally admitted. We need go no farther for convincing proofs than the history of the recent cholera pestilence; the concurrent evidence of medical men, in every part of the world visited by this fearful pest, establishes inevitably the fact. The most salutary and efficient results, invariably resulted from proper sanitary measures. The celebrated Dr. Rush wrote, seventy years ago: "To all natural evil, the Author of nature has kindly prepared an antidote. Pestilential fevers furnish no exception to this remark. The means of preventing them are as much under the power of human reason and industry, as the means of preventing the evils of lightning and common fire." All medical experience confirms the accuracy of this statement. These means should engage the serious attention of the physician. It is as much his duty to prevent disease as to cure it when once developed. He thus materially contributes to the great end and object of his mission—the saving of life; the mitigation of suffering; and the consequent amelioration of the suffering of his fellow-men.—C.]

89. But there are diseases occurring epidemically without any discoverable connection with season or temperature. Thus an epidemic influenza may come on at any season of the year, rapidly spread through a country, and cease as unaccountably as it began. So, too, diseases that are usually excited by other causes, infectious and others—such as typhus and scarlet fevers, measles, smallpox, erysipelas, &c.—sometimes prevail throughout a country so generally, and often with such peculiar characters, that some influence besides their common causes must be concerned in their sudden increase. The nature of this influence is unknown; but it is called *epidemic* (§ 87).

90. Lastly; various diseases, fevers, and inflammations, and almost all sorts of ailment, at some periods assume a remarkable character in common or *type* (as it is called); for example, being attended with unusual weakness, or unusual excitement, or a tendency to hemorrhage. This is called an *epidemic* or *prevailing diathesis*, or *constitution*. Thus at uncertain times, fevers, wherever arising, and from whatever source, are more low, typhoid, or adynamic, than usual; at the same time, exanthematous diseases generally partake of the same character; and even patients affected with inflammations do not well bear the usual deple-

tions. Of late years, this constitution has more or less prevailed, and may be contrasted with a period of twenty years ago, when an inflammatory diathesis existed, and bloodletting was advantageously employed even in continued fever.

91. It has been before stated (§ 88), that we are quite in the dark as to the nature of epidemic influences, or causes of disease. Many conjectures have been advanced, some of them with much plausibility, but without any substantial support. Dr. Prout states that, shortly before and during the prevalence of the malignant cholera in this country, he noticed a small but decided increase in the average weight of the atmosphere, as if from the addition of some ponderous gas. At the same time, he remarked an unusual acidity in the saliva even of healthy persons, and such an absence of lithic acid from the urine, that he seems inclined to suppose that a disposition to form oxalic acid was referable to the same unknown cause which was then producing cholera (§ 60).

92. Many analogical arguments may be adduced in favor of a favorite notion of Linnæus, that epidemic diseases are caused by animalcule tribes. This hypothesis [first broached by Kircher, and sanctioned by Linnæus—C.] has been ably advocated by Dr. Holland[1] and Dr. Henle,[2] [and Dr. J. C. Nott, of Mobile.[3]—C.]. Before I had seen the opinions of these authors, I had stated in my lectures some arguments in favor of this notion, which will be given under the head of infection. The chief facts which countenance this view, are the following: 1. Epidemic diseases, in the uncertain periods and places in which their visitations occur (§ 88), resemble those of blights, or tribes of insects which are known to appear and disappear without evident cause. 2. Proofs are accumulating of the occasional existence of parasitic animals and plants in living animals, and in some instances as causes of disease (as in the case of worms and other entozoa, acari in itch, the rot-worm in sheep, the mycodermatous vegetations in porrigo,[4] confervæ in impetigo, aphthæ, &c.). 3. The history and symptoms of some epidemic diseases, such as cholera and influenza, are not inconsistent with the hypothesis that they are caused by the sudden development of animalcules from ova in the blood. But there is a total want of direct observation in support of this hypothesis; and, perhaps, it may be objected against it, that the seasons at which epidemics sometimes appear (as cholera in winter) are not always those most favorable to the development of animalcule life.[5]

[This subject has been most ably handled by Professor Simon, in his lectures on Pathology. He observes: In sustaining this parasite theory, great ability has been displayed, and the facts recently ascertained, as

[1] Medical Notes and Reflections, 1840, p. 597.

[2] Pathological Researches, British and Foreign Medical Review, April, 1840.

[3] [New Orleans Medical and Surgical Journal, 1848.—C.]

[4] Gruby, Comptes Rendus, t. xiii. Bennett, Trans. Royal Soc. Edin. 1842.

[5] The prevalence of the south-east wind was observed to be particularly favorable to the increase both of cholera and influenza; and I cannot but think that this had some connection with the general tendency exhibited by the former to spread chiefly from east to west. Has the morbific property of this wind aught to do with the haziness of the air when it prevails—a haziness seen in the country remote from smoke, and quite distinct from fog? What is this haze? In the west of England, a hazy day in spring is called a *blight*.

to the connection of fermentation with infusorial and vegetable life, have been cleverly applied, and the evidence lately obtained regarding infectious disease, produced by parasitic influence in the lower animals, of which that curious disorder, the *muscadine* of the silk-worm furnishes the most remarkable example, has also been adduced in support of this opinion. The evidence on this subject varies in kind and conclusiveness. But great difficulty will be experienced, I think, in accepting this doctrine as a perfect solution of this intricate and debatable question. Recognized parasitic diseases, are from first to last essentially local. Both in the lower animals and in man, we are familiar with many parasitic disorders. In addition to scabies and hydatids, where the cause of the disease is an animal parasite, there are others where the parasitic growth is vegetable. Some forms of porrigo depend on parasitic vegetables—*mycodermata.* In *porrigo decalvans*, there is a peculiar *torula* developed within the hair, causing baldness, without coexisting disease of the scalp. Vegetable organisms have their epiphytic parasites. Their blights are epidemic. The minute fungi which constitute these diseases multiply with incredible rapidity; "frequently," says Sir Joseph Banks, in his paper on the Blight of Corn, "in the latter end of summer, must the air be loaded, as it were, with this animated dust, ready whenever a gentle breeze, accompanied with humidity, shall give the signal to intrude itself within the pores of thousands of acres of corn." Now, wherever this "animated dust" lights, the result is local, so like that in animals, that a celebrated botanist has called these diseases the *exanthemata* of plants. In each pore where a sporule enters, it grows and multiplies; it destroys the part; and if there be enough of them, they drain, they exhaust, and they starve the organism of the plant; their development is at the expense of the affected body. In the hydatids of sheep we notice the same result. Now there is no analogy here with the results from the inoculation of smallpox or syphilis. There is a great difference between these phenomena and those resulting from the contamination of the human organism from the animal poisons. There the general or constitutional irritation occurs only when the local irritation is extensive; or when the foreign parasitic bodies impoverish the blood, from their demands upon it; it is developed at the *quantitative* expense of the animal or vegetable. Their effects on life are in direct proportion to the extent of their local manifestness. The morbid poisons in high doses destroy before local manifestation or detriment commences. The poison of yellow fever, scarlatina, cholera, &c., may kill, and leave no sign. The patient may die in the first access; in the first tremendous shock or depression the vital powers sustain. At Muscat, ten minutes sometimes only elapsed from the first seizure of cholera before life was extinct. At Punderpore, the disease is said to have raged with such severity, that 350 persons died in the streets, tumbling over each other lifeless; or, according to an eye-witness, "as if knocked down dead by lightning."

Another strong objection to this theory is, that its advocates have failed to show the presence of parasitic bodies in connection with the specific diseases. The cholera fungi were a miserable delusion. You do not find them in the pustules of smallpox; in the virus of a chancre.

Not only, then, do not analogous symptoms to those observed in recognized parasitic diseases, in those affections where parasites are constantly found, occur in epidemic and contagious disorders, but no evidence has been adduced by the supporters of the theory to prove their presence. It is only conjectured; they admit they have eluded discovery; they are, they admit, not yet tangible to the senses. Before, then, admitting that their doctrine is worthy of serious discussion, is it too much to ask that their occasional presence be alleged?—C.]

III. INFECTIOUS CAUSES.

93. The terms *infection* and *contagion* are applied to the production of a disease by a morbid matter proceeding from the body of another person who is, or has been, the subject of the same disease. The proofs that disease is thus progagated from one individual to another, are, first, the general one, that those who have intercourse with the sick are affected in much greater numbers than those who have not (§ 12); and, secondly, the direct and individual proof of infecting a healthy person with matter taken from a person in disease. This, although available only in some modes of infection, may be considered as a proof of the fact of contagion in general—that is, of disease propagating its kind.

94. I have just alluded (§ 93) to differences in modes of infection; they may be farther enumerated as follows:—

(1). Infection through wounds, or an abraded surface; as in hydrophobia, the morbid matter being contained in the saliva or guttural mucus of the rabid animal; and in cowpox, the matter being contained in the specific vesicle, and acting on a puncture or abraded surface.

95 (2). Infection by contact, different parts of the body being susceptible of different diseases; as the urethra and conjunctiva in gonorrhœa, the vicinity of the external openings of the passages in syphilis, the skin in scabies, the scalp in porrigo—the morbid matter generally proceeding from similar parts.

96 (3). Infection by exhalation from the breath, perspiration, or other secretion, conveyed through the air to the mouth and air-passages; as in the case of measles, scarlatina, hooping-cough, typhus, and other infectious fevers.

97. Some diseases may be propagated in several of these modes; smallpox, for instance, may be communicated by punctures in the skin (§ 94), by inoculation—application to the eye (§ 95)—and by diffusion through the air (96); and probably the same might be effected with other febrile poisons, if their precise source in the body were as clear as it is in smallpox. These different modes of infection merely show that the infecting matter can exist suspended in the air, as well as in a fluid or solid state; and according to these conditions, it may get access to the system by different avenues.

98. Many of those who are skeptical as to the reality of infection, aim their objections only against aerial infection, and do not question the other modes. But the difficult problem is, not that the infectious matter may be diffused through the air—our smell informs us that

animal effluvia are constantly so diffused—but the difficulty lies in the fact of infection by any mode; that is, that disease should propagate its kind. There are only two parallel cases in nature, in which analogous properties are possessed by matter. One is the case of what is called septic matter, leaven, or ferment; a little of which introduced into organized matter will promote changes and decompositions: "A little leaven leaveneth the whole lump." This property is supposed by Liebig and other chemists, to be chemical, operating in the manner of heat, by altering the molecular relations of compound matter; but by Turpin, Cagniard De la Tour, and others, it is stated that fermentation is caused by the production and growth of living molecules or vegetables, and that it spreads by the propagating power of these. This would transfer this case, that of leaven or ferment, into the next category (§ 99).

99. The other case analogous to propagation of disease by infection, is the vital power of generation; in this case, as in that of contagion, matter propagates its own kind in the animal and in the vegetable world. Does the matter of contagion consist of animal ova or vegetable seeds? Are infectious diseases the results of the invasions and operations of living parasites, disturbing in sundry ways the functions and structures of the body, each after its own kind, until the vital powers either fail, or succeed in expelling the invading tribes from the system (§ 16)? Such an opinion has been many times proposed, and is, in a degree, implied in the term *incubation* (sitting on eggs to hatch them), commonly applied to the period between the reception of the infection and the first appearance of the symptoms. In support of this notion, may be adduced the case of itch, which certainly infects by an insect, the itch-mite, and spreads by this animal's propagation; and the case of porrigo, or favus, which depends on a minute parasitic vegetable, and infects through its seeds or sporules.[1] But these, it may be objected, are instances of mere local disease, and by no means like the cases of infectious fevers and syphilis, which affect the whole system.

The case of smallpox and cowpox might seem to be more intelligible, because the infectious matter is found to reside in the incipient pustule; but this throws no farther light on the subject; and although M. Gruby has reported that he has found a few animalcules in the lymph of these vesicles, its disseminating property has not been traced to them.

[The term now employed to designate the specific exciting causes of contagious and infectious diseases is *morbid poisons.*

By *morbid poisons*, we understand a product which is the supposed *specific* cause of certain *specific diseases*, as syphilis, for example, glanders, scarlatina, smallpox, hydrophobia, and the like; a poison which has striking differences from all other poisons, but chiefly these; that whilst other poisons, as hydrocyanic or oxalic acid, act directly in proportion to their dose, becoming more or less deadly in proportion as more or less of them is brought to bear on the organism, you observe, on the contrary, that the morbid poison (the poison of contagion or infection) produces its characteristic results on the economy with as

[1] Schönlein, Müller's Archiv. 1839, p. 82. Gruby, Gazette Médicale, Juillet 17, 1841.

much certainty, and quite as malignantly, when received in the minutest conceivable doses, as when the system is saturated with it. And secondly, while other poisons diminish from the body, or at the most, remain stationary, morbid poisons undergo, within the body on which they act, a striking and singular increase.

The phenomena which follow infection with a morbid poison, consist of certain local changes, attended by a peculiar constitutional state. The *local* changes may be generalized as subacute inflammatory processes; attended, perhaps preceded, by the deposition of a *specific material*, which material in most cases contains an agent capable, by inoculation, of producing in another person the same symptoms as have attended its own generation in the original sufferer. The peculiar *constitutional state* is one essentially of depression; modified, no doubt, and mixed with those phenomena of reaction which the living body, from its intrinsic conservative elasticity, so to speak, always opposes to the direct pressure of exterior influences. Of the local changes, partaking of an inflammatory character, the pustules of smallpox, the cynanche, erythema, and kidney affection of scarlatina; the follicular intestinal eruption in continued fever; the suppurating tumors of glanders; the parotitis of mumps, may be cited as some amongst many illustrations. And it is because of these local differences in *effect*, that we are led to distinguish the *causes*, and to speak of them as effects. Syphilis never causes ulcers in the ileum, scarlatina never causes iritis. The causative poison of the one disease differs from the causative poison of the other, for on the self-same subject it produces different effects. Not so, or in a much inferior degree, with the constitutional state which precedes and accompanies the local changes. With slight modifications, the general or constitutional symptoms are the same in all the acute infectious diseases. We are not able to distinguish with certainty the nature of the poison, until the local manifestations occur. The admixture of the symptoms derived from local changes is the first evidence of the precise character of the malady. Our knowledge of its speciality depends on its local manifestations.[1]—C.]

100. The parasitic nature of infectious matters may receive some support from the little that is known of their general properties, which farther deserve to be mentioned on account of their practical importance. Infectious matter is destroyed by a temperature above 120° Fahr., and by strong chemical agents, especially chlorine; its activity is impaired by cold; and in case of aerial infection, by intense cold and free ventilation, it is rendered harmless. Hence many infectious diseases cease when hard frost sets in. On the other hand, warmth, closeness, and filth increase the virulence of contagion, and become, as it were, a nursery of pestilence. Nothing tends to promote the spread of an infectious disease more than crowding together several who are suffering under it. Each one is a separate source of contagion; and if these sources are multiplied in an apartment, the air will be contaminated in proportion. This is the chief reason why, in fever hospitals and fever wards, medical attendants and nurses escape infection much

[1] See Simon's Lectures on Pathology, &c.

more rarely than in hospitals where the fever patients are widely distributed among other patients.

101. It may be useful, again, to point out the peculiarities which distinguish infectious from endemic and epidemic diseases; for these peculiarities are proofs of the reality of infection as a separate cause of disease.

Infectious diseases first attack individuals in any locality, then gradually spread in the vicinity of those diseased, or in the direction where there is most human intercourse. Where care is taken early and completely to separate the diseased from the healthy, disease does not appear among the latter.

102. *Endemic* diseases may simultaneously attack many individuals in certain localities only (§ 81); they do not spread beyond these localities; no separation of the sick from the healthy will save the latter, but removing the healthy to another spot gives them security.

103. *Epidemic* diseases simultaneously attack numbers in any locality (§ 88); they increase not peculiarly in the vicinity of those first affected, nor in proportion to intercourse with them, but rather in proportion to the prevalence of other conditions that may be called predisposing or determining causes (§ 19).

104. It must not be forgotten that some diseases are suspected to originate and spread in two, or even all, of these modes. Perhaps this may be said of typhus fever, plague, cholera, and dysentery. It has been already mentioned that infectious diseases, as smallpox, scarlatina, and measles, are occasionally increased and modified by epidemic influences (§§ 90, 91); and the same thing may be said of some endemic maladies. So also the aggravation of contagious and epidemic complaints by endemic impurities (§ 85), makes it plain that all the class of causes may operate conjointly. It is under such circumstances of aggravation, or under those of strongly prevailing predispositions, as from famine (§ 21), fatigue (§ 23), confinement (§ 22), or mental depression (§ 28), that this class of diseases becomes so destructive as to be called pestilential, or malignant.

105. The direct operation of most of this class of causes is depressing, and, where they are strongest and prevail most, the resulting disease is one of depression, *adynamia*, *asthenia*, or prostration of the vital powers. These causes, as exhibiting a noxious property opposed to life, are therefore commonly designated *specific poisons*. But there is the antagonist principle of vital resistance in the system (§ 16), which leads to various processes of reaction, which may be exhibited in different degrees, according to the relative strengths of the poison and of this resisting power; and likewise often according to various cognizable agents which simultaneously act as predisposing, determining, or cooperating causes. For instance, in warm weather the poisonous influences are generally strong (§§ 84, 100), and the bodily powers weak (§ 24); the resulting disease is one of more complete adynamia. In moderately cold weather, on the other hand, the specific poison is less active, and the system is ready to react, not only against it, but against the cold with which it may be combined; this causes a more inflammatory type in the consequent disease (§§ 79, 81).

CHAPTER II.

PATHOLOGY (PROPER)—THE NATURE AND CONSTITUTION OF DISEASE.

106. Disease is a change from the natural condition of the function or structure of the body (§ 6, *et seq.*); but the change is generally more or less compound, involving several elementary functions or structures; and it is obvious that we cannot obtain an accurate knowledge of the nature of disease until we have ascertained that of its component parts. As the anatomist and the physiologist examine structures and functions by separating or analyzing them into their constituent parts, before he contemplates them in combination, so should the pathologist study these constituent parts, or elements, in *disease*, before he can understand their combinations.[1]

The chemist, in the examination of his subjects, finds that there are some principles or elements that cannot be analyzed or divided further; these he calls ultimate or primary elements; others, again, are simple compounds, which may be analyzed; but they occur so constantly, and act so singly in compounding and giving properties to complex matter, that they are called proximate principles or secondary elements. A parallel case might be shown of physical science.

107. So it should be with physiology and pathology.[2] There are the healthy and diseased *primary* or *ultimate elements* of *structure*—muscular fibre, nervous matter, vascular fibre, and the elementary tissues of membranes, glands, skin, and other parts; and there are *primary elements*, healthy and diseased, of *function* of these same structures—irritability, tonicity, nervous properties, to which may be added, because at present we cannot analyze it, the power of secretion and nutrition; and lastly, the constituents of the blood. And there are the *secondary* or *proximate elements* of disease, composed of the preceding primary elements, but still simple in comparison with the complex conditions of disease which they combine to produce.

[1] A neglect of this precept has greatly retarded the advancement, nay, even the formation, of pathological science. Men have begun with the very complex problems of *inflammation* and *fever*, before they have made themselves acquainted with the elementary properties of textures or even of vessels. The result has been that the most profound reasoning and ingenious speculations have been wasted on nonentities, such as spasm of the extreme vessels, increased action of the capillaries, &c.; and even observation has been confused by the complexity of the subjects brought under it.

[2] I have pursued this synthetic mode of teaching general pathology in my lectures, from the year 1839 to the present time. I am not aware that it has been fully used by any other writer, although several (as Andral and Carswell) have partially recognized it in their divisions of the objects of morbid anatomy; and my friend, Dr. Symonds, has adverted to the parallel of chemistry, and actually employed the term proximate principles of disease in the same sense in which I use it.—*Tweedie's Library of Practical Medicine*, vol. i., *Pathological Introduction.*

108. The varieties of disease affecting these several elements may be comprehended under the heads of *degree* and *kind;* degree, including *excess* and *defect*, or alterations of *plus* and *minus ;* and kind, relating to changes not comprised under these heads, but otherwise expressed by the term *perversion*. By applying these heads to the elements of structure and function, we obtain a simple and comprehensive classification, which embraces all the important topics of general pathology.

109. The following table presents this classification applied to the primary or ultimate elements.

PRIMARY ELEMENTS OF DISEASE.

PRIMARY CONSTITUENT.	FUNCTION.	DISEASE.	STRUCTURAL DISEASE.
Contractile fibre	Irritability, Tonicity.		
Nervous structure . . .	Sensibility, Vol. motion, Reflex action, Sympathy.		
Secreting structure	Secretion.		
Constituents of the Blood:— Red particles, Fibrine and white globules, Albumen, Oil, Salts, Water.		Excess,	Hypertrophy.
		Defect,	Atrophy.
		Perversion,	Degeneration, &c.
Changes of the Blood:— By Respiration, — Secretion, — Assimilation, — Foreign matters.			

110. In the choice of proximate or secondary elements of disease, we must be more arbitrary and less comprehensive ; otherwise we shall encroach on the domain of special pathology. The vascular system and the nutrient function, so intimately connected with it, present us with the best and most important examples of proximate elements, comprising, as they do, two or more of the preceding ultimate elements (irritability, tonicity, constituents of the blood, secretion, &c.), yet so universal throughout the body as to belong to the province of general pathology.

PROXIMATE ELEMENTS OF DISEASE.

The blood in circulation	Defective—Anæmia	General		
		Partial		
	Excessive—Hyperæmia	General—Plethora	Circulation	Increased—Sthenic.
				Diminished—Asthenic.
		Partial—Local hyperæmia	Circulation	Increased—Determination.
				Diminished—Congestion.
				Partly inc. / Partly dim. — Inflammation.
	Perverted—Cachæmia			

Nutrition of Textures	Defective—Atrophy.	
	Excessive—Hypertrophy.	
	Perverted—	Degenerations.
		Deposits.
		Growths.

These primary and secondary elements of disease are the especial subjects of general pathology. By the study of them we become acquainted with the materials of disease, and their relations to each other; we learn how special diseases arise, and of what they consist; how they produce their phenomena and effects; how they are to be known, distinguished, and classified. Out of such a knowledge, where it is correct, sufficient, and combined with an ample acquaintance with the properties of remedial agents, arises the rational method of relieving, curing, and preventing disease, the great ends of the art of medicine.

I readily admit that our knowledge of these elements or principles in pathology, is as yet too limited to be entitled to rank as a complete science; but I think that the attempt to describe and illustrate them will be useful, not only by making available all that is known on the subject, but also by showing what is not known, and needs investigation; thus suggesting fit subjects for farther research.

FUNCTIONAL OR DYNAMIC DISEASES.

PRIMARY ELEMENTS.

SECTION I.

PROPERTIES OF THE MOVING FIBRE.—IRRITABILITY.

111. Irritability, irritable contractility, or the property of contracting on the application of a stimulus or exciting agent, is the distinctive property of muscular fibre. Although some physiologists maintain that this property is derived from some part of the nervous system, they have not produced any conclusive proof to that effect; it is, therefore, more philosophical to retain the Hallerian view of intrinsic irritability.[1]

[1] Dr. M. Hall ascribes irritability to the spinal marrow; but he mentions an experiment which is conclusive against this view: "During the half lethargic condition of the frog in winter, the entire cerebrum and spinal marrow may be removed, by slow degrees, at considerable intervals; the circulation is nevertheless good."—*Gulstonian Lectures*, 1842, p. 60. The irritability of the heart, therefore, is unimpaired. The late experiments of Dr. John Reid, on muscular irritability, are strongly in support of the Hallerian doctrine.

It may become *excessive*, so that the contraction is too violent for the welfare of the part or of the system. This constitutes spasm or convulsion. The excess of irritability may be manifest in three ways: 1. By an excessive strength and degree; 2. By an inordinate quickness, or promptitude; 3. By the unusual duration of the contractions.

112. (1). Excessive strength of muscular contraction is exemplified in the violent action of the heart during exertion or other excitement; and in the extraordinary muscular power of a delirious patient, who can master persons naturally stronger than himself. This exaltation of the natural property may depend on the excessive stimulus, as of blood in the heart, or of nervous excitement in the case of the delirious patient; or it may arise from the muscles being over-fed with blood.

113 (2). Inordinate readiness or quickness of contraction constitutes mobility of muscle, a slight stimulus causing it to contract. This often coexists with want of power or completeness in the contractions. It is exemplified in the irritable heart, which, although acting very frequently, does not expel its contents so vigorously as in health. It is seen in the quick nervous movements of irritable persons, who are at the same time weak. The bowels show it in that irritable looseness formerly called lientery, in which food is quickly passed little altered; and it is instanced in the irritable bladder, which will not hold even an ounce of urine. The pathological cause of this kind of inordinate irritability is either an undue flow of blood to the muscle, which exalts its natural property, or a predominance of irregular nervous influence, which unduly excites this property; thus it is often excited by irritations of the motor nerves, or of their columns or fibres. But the most remarkable examples are given in the extreme case of *convulsions* or *clonic spasms*—that is, sudden contraction, alternating with relaxation, as seen in chorea, epilepsy, and convulsive hysteria, where it affects the voluntary muscles; and in the palpitating heart, which beats irregularly and out of rhythm.

114 (3). An unusual duration of muscular contraction constitutes *tonic spasm*, or *cramp*, in which the contraction is strong, and not alternated, as usual, with relaxation. Such spasms are not unfrequently felt in the calves of the legs; and in the different muscular canals, the gullet, the stomach, the intestines, and the glottis, which occasionally present this state of continued contraction. In most of these cases, it is accompanied by pain more or less severe, and may lead to serious obstruction to the function of the organ. When in a more moderate degree affecting the voluntary muscles generally, it constitutes catalepsy, in which, from the muscles remaining contracted, the limbs will retain whatsoever attitude they are placed in, until the spasm is over. But the extreme example is tetanus, in which the spasms are so violent and so enduring, that they may be said to squeeze the patient to death. The pathological cause may be, as in other modifications of irritability, either an irregular supply of blood to the muscle, or irritation, direct or indirect, of the motor nerves by which the muscles are excited.

115. *Remedial Measures.*—These must depend on the cause of the excessive irritability. Where there is increased flow of blood to the part, bloodletting, derivants, sedatives, and other remedies for determi-

nation of blood, may be proper. Firm pressure on muscles affected with spasm or cramp, will promote their relaxation. I have succeeded in opening the jaw in trismus, by using strong steady pressure on the masseter muscles. Where the cause is nervous irritation, narcotics are the most effectual; and some of these, from their peculiar efficacy in allaying spasm, are called antispasmodics. The most powerful of these are stramonium, belladonna, sulphuric ether, in draught or inhaled, opium, and Indian hemp. Where irritability is combined with weakness, tonics are often serviceable, especially the metallic tonics and bark. In such cases the muscles are usually weak and ill-nourished, and their excitability is dependent on exalted function of the excito-motory nerves; the remedies will therefore be noticed under the head of nervous diseases.

116. Muscular contractility may be *defective* chiefly in two modes. 1. In force (§ 112); as in the weakness of voluntary muscles during severe illness, after fatigue (§ 68); or under the influence of a depressing poison or shock (§ 55); and in the weakness of the heart under similar circumstances, and in faintness, or in the sinking which precedes death. This weakness is caused by the exhaustion of previous exertion, or by want of a due supply of blood, which is necessary to maintain all functions; or it may proceed from an influence positively depressing or destroying the muscular power, as in the case of sedative poisons, as tobacco, sulphuretted hydrogen, &c., and probably concussion and other violent injuries to the organization. The extreme effect of these agents is to cause paralysis, or complete loss of irritability, which, affecting the heart, constitutes death by syncope. Muscles sometimes lose their irritability by more gradual causes, such as rheumatic inflammation, the action of lead, &c. Muscles are reduced in power either by over-excitement or exertion on the one hand, or by disuse on the other; this is exemplified in the paralysis of the sphincter after over-distension of the bladder, torpor of the bowels after the operation of an active purgative, &c., and in the weakness and ultimate palsy of the muscles of an anchylosed limb.

117 (2). Muscular irritability may be deficient in readiness to contract (§ 113), as in the sluggish movements of a person whose irritability has been lowered by opium; and in the slow pulse caused by digitalis, and by some cerebral affections; and in some cases by blood-letting or low diet. It is by no means clear why the same agents should lower in some cases the strength, and in others the promptitude in contraction; and in many other respects, the laws of irritability require further investigation. A benumbing degree of cold greatly reduces the irritability of muscles; yet the sudden dash of cold water will sometimes restore power reduced by exhaustion or sedatives.

118. Although it has never been proved that muscular irritability is *derived* from the nervous system, yet the illustrations already given plainly point out that it is much under its influence. The nerves are the proper medium by which the voluntary muscles are made to act, and through the nerves the motions of the involuntary muscles are influenced, as instanced in the operation of mental emotion on the action of the heart (§ 69). Hence diseases of muscular action gene-

rally rank with nervous diseases. Thus disease of the brain may cause a cessation of muscular motion by suspending volition; and disease of the spinal marrow or nerves may do so by intercepting the influence of the will; in either case, motion of a muscle ceases, not from disease in itself, but for want of its proper stimulus. In fact, under these circumstances, muscular irritability sometimes accumulates (§ 111), and is brought into action by slight impressions reflected from the spinal marrow. Thus, in complete paraplegia, or loss of motion of the lower half of the body, convulsive movements may be excited in the lower extremities by tickling the soles of the feet; in other cases of paralysis, they may be produced by electricity.

119. *Remedial Measures.*—As usual, these will vary with the cause of the defective irritability; where it proceeds from exhaustion, repose is the obvious indication. But even here, in extreme cases, and more particularly in those of the second head (§ 117), it may be necessary at once to excite the defective irritability by stimulants, especially those of the more diffusible kind, as ammonia, brandy, and other spirits and essential oils; whilst the feeble circulation and restoration of muscular power may be aided by heat and frictions. The large quantity of stimulants borne by patients whose irritability is reduced by accident or disease, is a remarkable feature in their history. A person faint from great loss of blood (§ 71), a crushed limb (§ 55), or a sedative poison, will bear four or five times more brandy than would be sufficient to intoxicate him under other circumstances. Electricity and the dash of cold water should be mentioned among temporary means of exciting defective irritability. Strychnia and cantharides given internally, are reputed to restore power to paralyzed muscles; but the same agents act much more energetically when directly applied to the affected part by means of blisters. So likewise stimulant frictions, warm douches, and such means of promoting a vigorous circulation throughout the weakened muscles may assist in restoring their strength; and generous diet, with tonics and a healthy air, render the blood richer in fibrine, by which the muscles are nourished.

SECTION II.

TONICITY.

120. TONICITY, or tone, is a property possessed by all muscular structures, and by some which are hardly accounted muscular. It is a tendency to slow, moderate contraction, not essentially terminating in relaxation; but it keeps the parts in which it resides in a certain degree of tension. This tone keeps muscles and limbs in their places when at rest, and out of their places when dislocated; if one set of muscles is paralyzed, the tone of their antagonists draws the parts in an opposite direction, as we see in paralysis of the portio dura on one side of the face. A similar property is possessed by the intestinal tube, the urinary bladder, the air-tubes, and the middle coat of the arteries, and gives

them a constant tendency to contract on their contents. In these, but particularly in the arteries, it performs an important part, both in health and in disease. By this the arteries contract, when they cease to receive blood from the heart, and thus are found empty after death. It adapts them to different degrees of fulness, yet maintains in their walls a certain tension favorable to equality in the motion of the blood.

It has been asserted that tonicity is quite distinct from irritability, and although irritable fibres possess tone, tonic textures are not irritable. This is not true with regard to the arteries; for I have many times distinctly seen them slowly contract, and remain contracted, at a point to which an irritant, mechanical, chemical, or electric, has been applied. The late discovery, by Henle, of a structure distinctly muscular in arteries, confirms this observation. I have proved, in like manner, the irritability of the air-tubes, which move more rapidly under a stimulus than the arteries; whilst that of the intestines is still higher in degree, but still inferior to that of the œsophagus and voluntary muscles, the contractions of which, on the application of a stimulus, are abrupt, and immediately followed by relaxation. So far, then, it appears, that tonicity is influenced by the same agents which excite irritability; but another agent, temperature, seems to affect them differently (§§ 74, 75). Cold increases tonicity and impairs irritability. Under the influence of cold, vessels generally, but especially arteries, shrink in size very remarkably;[1] and the muscles and other textures present a firmness and contraction which impede the quickness of motion characterizing the highest degrees of irritability. Under the influence of heat, on the other hand, although muscles are relaxed, they are more irritable, and the pulsations of the heart are more frequent.

Cold and heat, therefore, become the best tests for tonicity; and by their means we find this property to be possessed by textures which are not distinctly muscular; I mean, the veins and the cutis, which, in a remarkable degree, contract with cold, and become relaxed with heat.[2]

Now this property, tonicity, is a very important one in the animal economy, its natural condition being very necessary for the preservation of health, and its modifications being concerned in causing and constituting disease, more particularly in the vascular system. Practical men have long admitted the existence of something of this kind, without defining or localizing it; and the terms tone and atony, bracing and relaxation, tonic and relaxing remedies, become quite appropriate in

[1] This fact must be familiar to every one who has noticed the difference of the pulse when a limb is cold and when it is warm. But I have seen it more forcibly illustrated by experiment. On plunging into cold water the aorta of an ass just dead, it contracted so closely as to obliterate its cavity; and it required some force to pass the little finger into it. The crimping of the flesh of fish is referable to the same principle.

[2] It is difficult to assign the limit between textures that are irritable and not irritable. Thus some large venous trunks, as the cava, have been found by Valentin to exhibit slight contractions on the sympathetic nerve being irritated; and fibres like those of an unstriated muscle, have been found in their coats. The irritability of the dartos is well known; but I have frequently seen the skin of the trunk and limbs contract, and cause the projection of the papillæ (presenting the appearance of the cutis anserina), on gently scratching or tickling the surface, the appearance being confined to the vicinity of the part tickled.

connection with this property. Let us notice some of the characters of its *excess* and *defect.*

121. Where there is an *excess of tonicity*, the muscles are so firm that there is scarcely room for supple motion; the pulse is hard, tense, and often slow, yet there is scarcely any interval between the heart's beat and the radial pulse. The capillary circulation is active, and the extremities warm; but owing to the tense state of the vessels and of the skin, the secreting organs do not act freely, the urine is high colored, the bowels are disposed to be costive, and the skin to be dry and hot. The vascular system is in a state of high pressure, under which any weak part may give way, and induce local congestion or flux, active hemorrhage or inflammation, apoplexy and gout; but there is less than usual proclivity to suffer from cold, endemic and infectious influences, and others of a depressing character. The causes of excessive tonicity may be an over-nourishing and stimulating diet; with want of sufficient exercise; a dry bracing air; tonic medicines, such as iron and bark; the excitement of fever, &c.

122. *Remedial Measures.*—In such a state bloodletting will reduce the tension of the vessels, but only for a time. As long as the tonic fibres are too much braced, and the pulse hard, the secretions will be defective, and the vessels will fill again and renew the evil. The measures best suited for this state of excessive tone, are those tending to relax the tonic fibre, and increase the secretions; such as warm bathing, exercise, sudorifics, aperients, and diuretics, with moderate diet. It is probable that some remedies such as antimony, reduce directly the tone of the vascular fibre, acting as relaxants. We shall have to advert to this subject again under the head of inflammatory fever, of which the element, excessive tone of the vascular system, is a chief constituent.

123. Where tonicity *is defective*, the muscles are flabby, and incapable of continued exertion, but sometimes are too irritable, with the tremulousness of debility (§ 113). The heart, likewise, is irritable, and often exhausts its strength in palpitation; the pulse is soft and yielding; it may be full when slow, and sharp when frequent; but it is without firmness or endurance, and is easily accelerated. Another distinctive character is its retardation, increasing the interval between the heart's beat and distant pulses; so that the radial pulse is often felt after the second sound of the heart is heard (§ 121); the tubes being less tense, the pulse-wave is slower than usual (§ 120). Sometimes the absence of that tightening of the walls of the arteries, by which the tonic fibres control their movements, permits their mechanical elasticity to come into play, and this reacting after each stroke of the heart gives that peculiar reduplication or rebounding of the pulse, which has long been described under the term *dichrotous* pulse. This is often observed in convalescence from fevers and other diseases, after the subsidence of vascular excitement. A loose, relaxed state of the vessels renders the circulation in distant parts weak, so that the extremities are cold, whilst the head and internal organs may be congested. Sudden exertion or change of posture may disturb the circulation and cause faintness or giddiness.

Want of tone also in the stomach and intestines causes indigestion and costiveness, and permits them to become distended with wind and accumulating feces. The secreting organs, irregularly supplied with blood, are also liable to disorder, being either scanty, depraved, or profuse and watery.

It is quite obvious that a person in such a condition must be prone to various diseases. He has no resisting power (§ 16) against malaria, infection, or other depressing agents. If he is exposed to cold, the blood is readily driven through the weak vessels into the interior (§ 79), where it causes congestion or inflammation. The weak intestines have no power to expel offending matter from them (§ 57). Thus the system in a state of atony is open to the action of many exciting causes of disease; besides being itself in many respects on the verge of disease, especially congestion and its consequences, and other derangements of the circulation.

The causes of loss of tone are various debilitating influences (§ 28, *et seq.*), such as continued and exhausting excitement of the vascular system (§ 64), continued heat, especially with moisture, confinement in impure air, defective nutrition (§ 63), imperfect excretion (§ 68), &c. Muscles lose their tone from want of exercise, and bloodvessels from the continued operation of cold (§ 77). The tonicity of the arteries is liable to be influenced remarkably by the nervous system; and we shall hereafter find that a relaxation of the arteries of a part is the chief cause of local determinations of blood.

124. *Remedial Measures.*—The proper remedies for defective tonicity are tonics, which are agents that tend to increase the tone of the whole system (§ 120), particularly of its muscular and vascular parts. We have already stated that cold has this effect in a marked degree (§ 30), and in truth, cold properly applied, is one of the best tonics which we possess. For this purpose its application should be sudden, and too brief to cause depression or any of its morbid effects. The shower-bath and plunge-bath are the most effectual forms; and free sponging, with cold salt water, is applicable even to weak subjects. A pure bracing air and much exposure to it, with moderate exercise, have also useful tonic effects. There are many medicinal tonics, the most effectual of which are bark and its preparations, medicines containing iron and the mineral acids. Generous living may be considered a part of a tonic plan, in so far as it tends to enrich the blood, which sustains tonicity, as well as all other vital properties.

SECTION III.

FUNCTIONS OF THE NERVES.—SENSIBILITY.

125. Certain parts of the nervous system being known to the instruments of sensation, we have no difficulty in tracing diseased sensibility to this system; and as this system consists of a medullary centre, and of nerves converging from various parts to it, so we find that altera-

tions in the property may depend either on disease of the centre, causing disorder of *general sensibility*, or on disease of one or more of the nerves, causing disorder of *local sensibility*. These we shall now notice.

DISEASES OF GENERAL SENSIBILITY.

These may consist in—1, *excess*; 2, *defect*; 3, *perversion*.

126 (1). *Excessive sensibility* is more or less present when the nervous centres are excited in the early stage of their inflammation or of determination of blood to the head; where there is intolerance of light, noise, and motion. A similar condition exists in hydrophobia and tetanus from mere excitement, without inflammation. But short of these, sensibility is excessive in some persons, either congenitally (§ 41), or as a consequence of disease (§§ 31, 34). Such persons are commonly called nervous; they are worried with trifles; startled at shadows; distracted by noise or bustle; never free from some ache or pain; for almost every feeling is suffering; and what in others would be slight pain, in these amounts to agony. Hence they are perpetual invalids, quite unfit for the rugged path of life, over which they, as it were, walk barefooted and thin-skinned. If real disease attack them, its nervous symptoms are so much exaggerated, that a medical attendant is apt to fall into the error of either ascribing all to "the nerves," or of measuring the disease by the severity of the symptoms. This over-sensibility is generally conjoined with excess of irritability, and want of tone (§§ 113, 123). Other nervous functions, such as sympathy and reflex action, are also often augmented or in disorder. The symptoms connected with sensation most frequently present, are neuralgic pains of various parts, excessive sensibility of the surface, headache, pain in the back or left side, and spinal tenderness.

127. The pathological cause of increased general sensibility is probably a slighter degree of the same cause which induces it in the early stage of encephalitis, an undue supply of blood to the posterior columns of the spinal marrow, the corpora restiformia, and the parts of the cerebral mass concerned in sensation. This local determination of blood may result from original development; but it may also be a consequence of inflammatory affections of the encephalon, of irregularities in the menstrual functions, or of the reaction ensuing after great losses of blood, all of which are known to be sometimes the precursors of morbid sensibility. On a future occasion, in connection with the subject of irregular distribution of blood, we shall endeavor to point out why great losses of blood and other causes of sudden weakness are sometimes followed by excessive sensibility. The extreme refinements and luxurious habits of the upper classes, with more excitement for the mind than exercise for the body, and for the feelings than for the understanding, are well calculated to foster this over-sensitive state.

128. *Remedial Measures.*—The medicines most directly in opposition to this element of disease are narcotics or anodynes, such as opium, henbane, hemlock, Indian hemp, &c., administered internally, or, in some instances, applied externally; as where muriate of morphia is sprinkled

on the skin deprived of its cuticle by a blister. These diminish nervous sensibility; and in proportion as this is exalted (§ 126), the system will bear larger doses. But where the increased sensibility depends on inflammation or vascular excitement of the nervous centres (§ 127), the proper treatment will obviously be that to be hereafter described as antiphlogistic. Again; where the excessive sensibility arises from the nervous excitement of irregular circulation, from general weakness (§ 116), and loss of tone (by no means an uncommon combination), tonics (especially the metallic) (§ 124) and stimulants (§ 119), as well as narcotics, are the proper remedies. Weakness, softness, and slow transmission of the arterial pulse (§ 123), and absence of fever or permanent heat of skin, are the chief symptoms of such a condition. In these and other common cases of morbid sensibility, country air and exercise, cold or tepid bathing, especially with the shower-bath, plain food for both mind and body, early hours, and an avoidance of all enervating habits, are often more conducive to the cure than any medicines.

An anodyne influence, more powerful in degree than that induced by any other agent, although transient in duration, is that resulting from the inhalation of the vapor of sulphuric ether, which has, during the last year, been extensively used, first in America, and subsequently in this country. The operation of this agent, and of nitrous oxide gas (which has a similar effect), is on the sensorium, rather than merely on the sensitive nerves. In most instances, if continued for a sufficient time, it induces complete insensibility, so that the subject may undergo the most severe surgical operation, and a female may go through the process of parturition, without suffering any pain. In many cases, however, especially where the inhalation has been less prolonged, or less impregnated with ether, sensibility is blunted, but not destroyed, and the patient makes movements, and may utter expressions, indicative of slight pain, yet has no recollection of it when restored to consciousness. The memory seems to be more affected than the perceptive function. The power of voluntary motion is suspended in about the same ratio as sensibility; but the reflex motions of the eyelids, breathing, &c., are lowered, but not abolished, unless the inhalation be continued so long as to induce complete asphyxia.

The operation of ether vapor is obviously narcotic, like that of opium and alcohol; and is more speedy and transient, because it passes freely and directly through the lungs into the arterial blood, and affects the brain, and is as promptly dispersed by its diffusion throughout the body. It has been maintained by many that it operates by its interference with the respiration, inducing a degree of asphyxia; but so far is this from being the case, that its best effects are produced when the respiration is steadily maintained; and it has always appeared to me that the end to be aimed at in the administration of ether vapor, is to narcotize, as far as possible, without too much embarrassing the breathing. This is difficult to accomplish without a freer supply of oxygen than atmospheric air contains; and I should expect safer and more satisfactory results from the inhalation of a mixture of ether vapor with oxygen gas, which might be continued with safety for a much longer period than with the vapor and air only.

Although the chief influence of etherization is transient, yet by saving the nervous system from the shock of intense temporary pain, during an operation or paroxysm of suffering, it often prevents that consequent nervous irritation and exhaustion which are so injurious to the vital powers, and which favors the return of the painful attack. Thus in neuralgic and painful spasmodic affections, the removal of one or more paroxysms by etherization may break the habit of diseased action, and effect a permanent cure.

129 (2). *Defective* general sensibility, in its extreme degree, is exemplified in coma, from the circulation in the sensitive centre of the nervous system being impeded by pressure, congestion, or other obstruction (§ 52), or from narcotic influence. Thus a person in a fit of apoplexy, or poisoned by opium, has lost all feeling, as well as voluntary motion. When the blood becomes impure by retention of excrementitious matter, as in suppression of urine, a like stupor occurs (§ 68). Very rarely *anæsthesia* exists—that is, loss of sensation, without loss of motion. But short of these degrees, there are some who congenitally (§ 44), from disease (§§ 31, 34), or from age (§ 48), are *deficient* in sensibility—feel less than other folks. All their feelings are obtuse, and their actions slow; they have no intense suffering or pleasure. Such persons have also little irritability, but much tone of fibre, and are remarkable for their immunity from many diseases. But they are the more liable to others; such as fulness of blood, apoplexy, gout, costiveness, and the various evils which these may bring. They contrast well with the over-sensitive in this, that disease, when it occurs, may be latent, advance far, and become dangerous, before it is felt; and may imperceptibly increase until it is incurable, or until sudden death ensues.

130. *Remedial Measures.*—When obtuseness of feeling arises from fulness, obstruction, or pressure of blood in the nervous centres, the treatment will consist in attempts to remove these by depletion, derivation, and other means to be mentioned under the head of disordered circulation. Where there is no actual disease present, but merely a torpor of the sensitive function, mental excitement, bodily exertion, the cold dash and friction, are the best means of arousing the nervous system from its state of lethargy. The insensibility from narcotics and from retained excrementitious matters should be counteracted by means calculated to eliminate the stupefying matter by the natural outlets, such as purgatives, diuretics, emetics, &c. It is doubtful whether we have any medicine capable of directly increasing sensibility. Strong tea and coffee, perhaps, have the best claim to such a property. What effect would arise from electrifying the spine and occiput? Stupor and impaired sensibility may arise in a state of anæmia, as in cerebral syncope, and in children or females who have lost much blood; this is from stagnation of the blood in the brain. Under such circumstances, the pallor of the skin and weakness of pulse would indicate stimulants as the best means of restoring sensibility.

131 (3). *Perverted* general sensibility is often manifested by those in whom there is also increased sensibility (§ 126), but its character is in

the peculiarity of the sensations which are experienced. Thus sensations of tingling, prickly heat, trickling cold, in various parts; feelings of a lump in the throat, a hot ball in the side, a fluttering at the stomach, and illusions of the special senses, may severally and variously affect persons whose sensibility is modified more in kind than in degree. Such persons may also have a depraved appetite, craving for sour things, cinders, mortar, and all manner of filth. These symptoms generally occur in females, often in connection with irregular menstruation; therefore, they are called hysterical; but their pathological cause must be sought in the nervous system, the functions of which, probably from irregular supply or bad quality of the blood which supports them, become disordered. The *remedial measures* indicated for this condition are, therefore, those calculated to remove its cause; chalybeates and other tonics, with pure air, nourishing food, and other means which improve the quality, and equalize the distribution of the blood. Narcotics and sedatives may be useful as temporary palliatives. In rare cases, the general sensibility is perverted by structural change in the nervous centres, such as softening of the cerebral structure.

DISEASES OF SENSIBILITY OF PARTS.

132. The feelings of a part may be *excessive*, *defective*, or *perverted*. This may be illustrated by experiment. By irritating or striking a nerve, pain is produced in the part to which it is distributed, and the sensibility of the part remains exalted; that is, it feels tender or painful afterwards. By pressing on the nerve, a new and perverted sensation, of tingling and pricking, with numbness, is caused. By pressing more strongly, or dividing the nerve, the feeling is farther impaired or altogether destroyed. Similar effects may be produced by a tumor, ligature, effusion, or other cause pressing on a nerve in its course. Disease of the nerve, or of a part of the spinal or cerebral matter connected with it, may likewise modify the sensation of parts. Thus inflammation of the sheath of the ischiatic or trifacial nerves may cause first neuralgic pain, and afterwards numbness in the parts to which the nerve is supplied. There are other painful affections which are to be considered and treated as cases of exalted sensibility, such as the irritable (as Dr. Billing observes, erroneously so called) breast, testicle, uterus, &c.

133. But the function of sensation, as other functions, depends on the supply of blood to the extreme distribution, as well as to the trunk and origin, of the nerves. Hence, if blood does not circulate freely through a limb, the sensations are impaired; and if it passes too freely, the sensibility is exalted, and there may be itching, tenderness, or even pain. In organs of special sensation, the senses are modified, together with the common feeling; thus, in disease of the optic nerve or retina, there will be intolerance of light, or specks and clouded vision, or even blindness; in the ear, ringing and beating noises, or deafness, besides the affections of common sensibility, itching, tenderness, and pain.

134. At the orifices of passages into the interior, there are peculiar kinds of sensibility connected with the functions of ingestion and eges-

tion ; these modified are elements of disease. As examples of such excessive sensibility, may be enumerated thirst, craving, nausea, tenesmus, and painful micturition ; of impaired sensibility, anorexia, and paralysis of the rectum and urethra.

135. When we come to internal parts, we have only to consider their sensibility when *exalted* by disease. We do not know that they naturally possess any feeling. Of the ordinary processes, as of the passage of food and feces in the alimentary canal, of the movement of the lungs, of the heart, and of the blood through the vessels, we are not conscious; but, under the influence of disease, we become painfully sensible of several of these motions. This excessive sensibility is developed by inflammation, as in pleurisy, peritonitis, meningitis, &c., or by irritation by mechanical or other means, as in colic, biliary and urinary calculi, gastralgia, perforation of the stomach or intestines, &c. It is very remarkable that pain from these, which is perhaps severer than any, should arise so suddenly in parts which give no evidence of common feeling.

136. In many instances we are to regard pain merely as a symptom to be removed only by means which remove its cause, the lesion which produces it (§§ 132, 133); but in many cases, on the other hand, although a symptom, it constitutes a chief element of the disease, and one against which remedies must be expressly directed. Thus it is in neuralgia, gastralgia, nephralgia, colic, dysmenorrhœa, and perforated intestine. So long as the excessive pain lasts, all the functions suffer (§ 66), faintness and exhaustion ensue, and, if no relief comes, the prostration may be fatal. Here, to mitigate or remove the pain, is a first and pressing indication. Again; in some other cases where the pain is less severe, it may be very hurtful, by interfering with important functions. Thus the stitch of pleurisy impedes the breathing; the pain of tenesmus and the irritation of the stomach or windpipe cause efforts at straining, vomiting, and coughing, so violent that the functions are thereby kept in a state of disturbance, and the strength is exhausted. Here it may be necessary to treat promptly for the pain on account of its immediately pernicious effects.

137. *Remedial Measures.*—Where excessive sensibility depends on inflammation, antiphlogistic measures will generally soon remove it. Where it lingers after the inflammation is out of proportion to it, or is independent of it, then anodynes become the chief remedy. The most powerful of these is the inhalation of the vapor of ether, above noticed, which is fairly applicable to the mitigation or removal of local pain of a temporary character. The most potent of fixed anodynes are opium and its active principles ; but these have morbid effects (impairing the secretions) (§ 70), which sometimes render them less eligible than the weaker narcotics, hemlock, henbane, stramonium, belladonna, and Indian hemp. The stronger preparations of aconite and its alkaloid are powerful anodynes, and are very valuable as outward applications ; but their depressing operation on the heart renders them unsafe for internal exhibition. These different anodynes are used both internally and externally. One of the most effectual methods with which I am acquainted,

for relieving severe local pain, is the endermic application of morphia; for this purpose a blister is applied to the painful part, and, when fully risen, the cuticle is completely removed, and the denuded surface sprinkled with one or two grains of a soluble salt of morphia (the acetate or hydrochlorate) in fine powder, which may be repeated once or twice daily, according to the urgency of the pain. The effect is first anodyne, then narcotic on the system, with much less than usual of the injurious effects of opiates by the mouth. The application loses all effect so soon as the blistered surface becomes dry. Counter-irritation and warmth are also means of relieving pain. The pain of gastrodynia may often be removed by a sinapism to the pit of the stomach; that of colic and dysmenorrhœa by hot fomentations, or bags of hot sand or salt, &c. In other cases, painful feelings may be relieved by such pressure on the part as will counteract tension, and diminish without stopping the flow of blood through the part. Painful affections occurring with a weak circulation, particularly if intermittent in their attacks, are often removed by tonics; thus neuralgia has been successfully treated with quinine and iron, hemicrania with quinia, or liquor arsenicalis.

138. We are not possessed of equal means of restoring lost sensibility. Stimulant applications and frictions are serviceable where the defect arises from deficiency of circulation in the part; and strychnia or cantharides given internally, and electricity used topically, *perhaps* may have some little effect in exciting the functions of the nerves, but more doubtfully in regard to sensation than to motion.

SECTION IV.

DISEASED VOLUNTARY MOTION OR EXCITO-MOTION BY THE WILL.

139. The function by which certain nerves convey the impulses of the will to voluntary muscles, may become disordered, and its phenomena constitute an element of disease. Some of these have already been noticed under the head of diseased irritability (§ 113); and it was there observed that the error is more commonly in the nervous influence which excites the muscles, than in the property of the muscles themselves. This is the case in most convulsive diseases, and in those cases of paralysis which depend on injuries of the voluntary nerves, or of those parts of the spinal and cerebral system which are the channels of volition. A brief illustration of these diseases will suffice to correspond with those of diseased sensation.

DISEASES OF GENERAL VOLUNTARY POWER.

140. The voluntary motor power may be said to be *generally in excess*, when the brain is excited by strong emotions or feelings (§ 66), by stimulating liquors (§ 56), and by the hurried circulation of frenzy, or

phrenitic delirium. Hysteria, as usual, can supply like examples. The strength and rapidity of movements displayed in hysterical cases are sometimes astonishing, yet they are obviously voluntary movements, for they are often performed rhythmically, or to a tune, as in dancing. The dancing of tarantulism, and the extravagant exertions of the fanatics called jumpers, would seem to arise from an erethism of the part of the nervous system concerned in voluntary motion. Short of disease, a naturally high voluntary power is evinced in the energetic and active movements of some persons, who excel and delight in feats of strength or agility. Mere muscular strength will not suffice without nervous energy to act on it.

141. *General volition* is more or less defective in apoplectic coma, stupor from various causes, pressure, congestion, narcotism, &c., where other nervous properties are also impaired (§ 129); in trance, catalepsy, and nightmare; in a less degree also in cases of lethargy and weakness from over-exertion (§ 68). This defect may be sometimes suddenly induced by terror, surprise, &c. (§ 69), which for a time take away the power of motion. Hence the fabulous power of the Gorgon's head; and the signification of the expressions, *petrified with astonishment*, *motionless with terror*, *fascinated*, and the like. The muscular power (§ 110) is not lost in these cases, but only the influence of the mind over it; that is, volition.

142. Examples of *perverted voluntary power* may be found in chorea, delirium tremens, and some analogous affections called hysterical. In these, volition may be often also defective (§ 141), but it is not always so; only each act of the will is perverted in its performance. The will sets muscles in motion, but the wrong muscles, or too many, too forcibly, or irregularly, so that the resulting action is not in accordance with the will.

PARTIALLY DISEASED VOLUNTARY POWER.

143. We can scarcely point out examples of partial *excess* of *voluntary* motion. The convulsive movements of voluntary muscles are quite involuntary, and have been noticed under the head of diseased muscular action (§ 113); but it was there mentioned that they may arise from irritation of the nerves, independent of the will. Hysteria does, however, furnish examples of excessive movements of one limb or part of the body, so far amenable to mental influence as to be excited and timed by ideas in the patient's mind. These cannot be said to be wholly involuntary; but are the results of a wilful impulse, perhaps too strong to be *easily* resisted.

144. *Partial defect* of voluntary power is very common, and, like local defect of sensibility, may be traced to partial disease of the motor (anterior) columns of the medulla and prolongations; or to disease of, or pressure on, a motor nerve in its course; or to a disordered condition of the ultimate distribution of the nerve, or of the circulation supporting its function. Thus paralysis of voluntary motion in an extremity or a whole side (hemiplegia), may arise from disease in the optic

thalamus or corpus striatum of the opposite side; these being the channels of communication between the cortical seat of the sensorial functions and will, and the motory columns and nerves. Lesions of the motory (anterior) columns within the spine, may intercept more or less the voluntary power of those parts supplied with spinal nerves from below the diseased point. Thus a lesion in the lower cervical portion may paralyze the upper and lower extremities and whole trunk (except the diaphragm, which is supplied by the phrenic nerve); a lesion in the dorsal or lumbar portion, paralyzes only the lower half of the body (paraplegia), or lower extremities. Or the disease may be more partial, paralyzing one nerve only, as the portio dura, causing distortion of the features; or the ninth nerve, causing difficult articulation, &c. The lesion of the nervous textures here alluded to, may be structural change, as tumors, effusions, or hemorrhage, or only an altered state of the bloodvessels of the part. Severe cold or continued pressure will impair voluntary power in a limb, by checking the free flow of blood, which is essential to the proper function of the nerves as well as of the muscles. Hysteria affords numerous examples of volition impaired in parts, as in loss of voice and power of articulation, retention of urine, paralysis of limbs, &c.; these affections may come on quite suddenly, and as suddenly cease.

145. *Remedial Measures.—Excessive* voluntary power is rarely an element of disease for separate treatment. As part of the excitement of the nervous centres, it may be reduced by sedatives of different kinds—depletion, antimonials, and cold to the head, being the most effectual, where the excitement is attended with determination of blood; morphia, and other narcotics, where the excitement is more purely nervous. The violent exertions of maniacs are wonderfully controlled by the cold douche to the head, sometimes with nauseating doses of tartar emetic. The vehement movements of those excited by fanaticism and tarantulism are ended by exhaustion; they might probably be checked by a timely ducking with cold water; which is often successful in hysteria.

146. The treatment of *defective* volition will consist in means calculated to excite the nervous centres, directly or through the medium of the circulation. Agents which restore free circulation of healthy blood through the nervous centres and branches, generally improve voluntary power. Thus a stimulant draught may raise the failing strength of a person fainting. By warmth and friction, one who is benumbed with cold recovers the use of his limbs. Sleep or rest will restore voluntary power exhausted by fatigue. Sudden and powerful mental excitement, as by a fright, has been known to restore voluntary power which had been long lost. A lady, who for several years had lost the use of her lower extremities, was startled by a rat running near her; having an extreme antipathy to the animal, she made an effort, and sprang upon a table near; the power, however, did not remain, for she could not get down again. A more permanent cure of impaired volition has been effected by the excitement of religious fanaticism, as in the cases of the supposed miracles of Prince Hohenloe, Miss Fancourt, &c. As we have found that such mental excitement sometimes causes excessive voluntary

motion in healthy persons (§ 140), so we perceive that, suddenly applied, it may restore it where defective.

But sometimes volition is defective from pressure on, or congestion in, the brain, which prevents the due motion of the blood through it, as in plethoric lethargy, or apoplectic coma; here depletion and derivation may sometimes restore the power. In the lethargy of narcotism and asphyxia, the volition is often restored by means which excite strong sensations, and reflex actions, as dashing cold water on the face and chest, ammonia or other stimulating vapors to the nostrils, electric shocks, stinging with nettles, &c. The trance or coma of hysteria may often be removed by a turpentine injection, or croton-oil purgative, which acts both as a revulsive to the vessels and a stimulant to the nerves.

Perverted volition will require various treatment, according to its kind; that of delirium tremens being corrected by narcotics, especially opium; that of chorea, by nervous tonics, especially iron and zinc.

147. The treatment of *locally diseased* voluntary power will generally commence with attempts to remove its cause, which we have found to vary too much both in seat and nature to admit of an elementary statement of remedial measures. Those for defective voluntary power comprehend the complex subject of the treatment of paralysis, which commonly comprises means calculated to restore to its proper state the circulation through the affected part of the nervous system, and sometimes, also, means which stimulate this part by exciting agents, such as electricity, stimulating frictions, and blisters; and strychnia and cantharides given internally, which are supposed to have a directly stimulant action on the motory columns and nerves.

SECTION V.

DISEASES OF REFLECTED AND SYMPATHETIC NERVOUS INFLUENCE.

148. The nervous property by which various movements and processes connected with organic life are excited, may be disordered, and its alterations are remarkable constituents of many diseases. The contractions of all the sphincters, of the œsophagus, the glottis, the iris, the eyelid, and the regular action of the muscles of respiration, seem to be sustained, independently of the will, by a nervous influence conveyed by afferent nerves from the respective parts or surfaces to the spinal marrow, and reflected from it through the efferent nerves to the muscles connected with these parts. The full establishment of this physiological principle we owe to Dr. Marshall Hall.

149. The *increase of this involuntary excito-motory* power is instanced in the spasm of the throat, and sometimes of the sphincters, in hydrophobia, tetanus, and some hysterical affections. The hurried

respiration, the convulsive cough, violent retching, and hiccough, which are occasionally presented in these and other nervous diseases, may also be in part traced to an undue influence of the excito-motory nerves of organic life. These actions are sometimes excited by sensations (§ 134), as the breathing by feeling of want of breath, cough by tickling in the air-passages, retching by nausea, &c.; but it is where either there are no such sensations, or where they bear no proportion to the violence of the actions, that we are warranted to conclude that the excito-motory function is itself exalted.

A similar exaltation of the excito-motory function, independent of sensation and volition, is exemplified in the voluntary muscles, when they are deprived of sensation and voluntary motion by disease in the brain itself, or cutting off communication between the brain and spinal cord, without materially injuring the cord itself (§ 118). Thus, in paraplegia from injury of the upper part of the spine, the excito-motory power of the nerves of the lower extremities is exalted; and tickling, or mere touching the soles of the feet or legs, will produce convulsive motions, although all voluntary power and sensations be wholly lost.[1] This phenomenon is sometimes so readily produced as to be a cause of much disturbance to the patient, the mere touch of the bedclothes exciting troublesome startings. The same thing occurs in hemiplegia, but less distinctly, as the cerebral influence is rarely here so completely intercepted. I have known, however, the convulsive motions of a paralyzed limb so violent, in a hemiplegic patient, that it was necessary every night to fasten it down to the bedstead to enable the patient to get sleep.

An instance of involuntary excitement of the muscles occurs in the symptom of "fidgets," which often arise from irritation reflected from the lower part of the intestinal canal, or from the uterus; and another is seen in the sudden retraction of the testicle by the contraction of the cremaster, on touching the inner part of the thighs, in disease of the kidneys, and other urinary organs.

150. Under this head, we must also glance at convulsions, which, according to Dr. M. Hall's views, and consistently with the phenomena of disease, must be referred to an irritation of the true spinal system. This irritation may be *centric*, as in epileptic and apoplectic convulsions from disease in the head, and those from loss of blood; in which cases, the spinal and prolonged medulla being excited, the excito-motory influence radiates to the limbs and muscles generally; or it may be *eccentric*, commencing with irritation of the extremities of some afferent nerve, which transfers it to the spinal centre, whence it is again reflected generally or partially. Such are the convulsions arising from teething, uterine, intestinal, and renal irritation; and a slighter degree is exemplified in the rigor caused by the sudden impression of cold on the surface, or by passing a bougie into the urethra of a nervous person.

[1] The same phenomenon is exhibited in a high degree in the decapitated frog, in which touching the surface excites convulsive movements. A still more interesting illustration sometimes occurs in animals or persons whose cerebral power (sensation and voluntary motion) is impaired by opium or other narcotics; spasms or convulsive actions of the muscles being induced by tickling or pinching the skin, which shows the excited state of the reflex or spinal function.

151. *Partial spasms* caused by *reflected irritation*, are exemplified in cramp in the legs from acrid matter in the colon, in diarrhœa and cholera; spasm of the glottis from a bone sticking in the pharynx, &c. More familiar examples of the same class of reflected irritation are found in sneezing from irritation of the nares, winking from irritation of the conjunctiva, coughing from irritation of the glottis, retching from irritation of the fauces, efforts to evacuate the rectum and the bladder from irritation of these parts respectively. But it must not be forgotten that all these latter examples are connected with obvious sensations; and they imply increased excito-motory influence only in those cases in which they are out of proportion to these sensations.

152. But some of the most remarkable instances of reflected irritation are displayed in the involuntary muscles, the heart, and the muscular fibres of the air-tubes and intestinal canal. Thus, inordinate action of the heart (palpitation) is commonly caused by irritating matters in the stomach or intestines, kidneys, or other viscera (§§ 51, 54); nay, we shall afterwards find, that the heart is liable to be excited by considerable irritation in any part of the body, as in fever and constitutional disorder. The spasm of the intestines in colic is induced by reflex irritation resulting from acrid matter in them; for if it were from direct irritation alone, the spasm would only affect the part touched by the offending matter.[1] The spasm of the bronchi, so suddenly occurring in spasmodic asthma, also sometimes arises from intestinal irritation. It has long been supposed, and is still a common opinion, that these morbid sympathetic movements are due to the direct nervous connection which the great sympathetic nerve establishes between the respective organs; but this supposition assumes, what experiment has not proved, that the ganglia of this nerve are either centres of reflection,[2] or sources of nervous influence, which is still more inconsistent with the latest researches. So far as we yet know, the spinal marrow is the centre of reflection in these as in all other examples of reflex action which we have been considering, although the sympathetic be the medium of communication.[3]

153. When phenomena of inordinate reflex actions are general or extensive, as in convulsions, tetanus, and paraplegia, we must refer them to an undue excitement or erethism of the spinal and prolonged medulla; but the more partial examples may arise from similar excitement of a small portion of it only, or of the incident (afferent) nerve of the part which occasions the phenomenon, or of the excito-motory (efferent) nerve of the part which exhibits the phenomenon.

If we seek to know the causes of this excitement, we shall find that, as in excess of other vital properties, it is sometimes referable to an increased flow of blood through the spinal marrow or its nerves, or the branches of the sympathetic nerve. Thus the early stage of inflammation of the spinal cord, or of its sheath, is attended with convulsions or tetanic spasm. It is very probable that the spinal excitement (convulsions) occurring in epilepsy and apoplexy, is in part due to the flow

[1] Müller's Physiology (by Baly), p. 737. [2] Volkman, Müller, p. 738.
[3] [Valentin, Carpenter's Human Physiology, p. 674, 5th Am. Ed.]

through the medulla being increased in proportion as that through the brain is impeded; a consideration of the causes of convulsive paroxysms, and of the distribution of the vertebral arteries, much countenances this supposition. But in many cases, the excitement seems to be of a more direct nature. Strychnia, in a poisonous dose, excites the medulla so speedily, causing tetanic spasm, that its effect can scarcely be due to increased flow of blood. So, too, we know that mechanical irritation of the spinal marrow, or of its nerves, will cause convulsive motions; and we find this exemplified in the effect of tumors and spicula of bone in the spinal canal, in the head, or in the course of nerves. But nothing exhibits this element of nervous irritation (apart, so far as is yet known, from vascular influence) so fearfully as traumatic tetanus. The irritation here begins in a distant nervous branch, and is propagated to the medullary centre, the excito-motory function of which at length exhibits a state of erethism, which destroys life either directly by tonic spasm (§ 114) of the muscles of respiration, or by exhaustion. Another cause, which may be fairly assigned for increase of the involuntary excito-motory property, is accumulation by rest. This causes the augmentation of this property in the medulla in narcotism from opium, and in injuries of the spine (§ 149), which suspend the exhausting influence of volition on the whole or part of the marrow, in which the nervous energy therefore accumulates, and becomes unusually abundant. There is a natural increase of this property in sleep, which, by suspending the sensorial functions, augments the energy of those of the medulla; and this accession of power, which maintains the movements of respiration during sleep, also disposes to the occurrence of spasmodic attacks at this time; hence the fits of epilepsy and asthma commonly come on during sleep. So likewise sedentary habits, and too much indulgence of sleep, may cause an accumulation and morbid excess of involuntary nervous power, and develop convulsive and spasmodic symptoms, which are the result of its overflow.

154. *Defect* of the reflex or involuntary excito-motory function is exemplified in the paralysis which affects the sphincters, the eyelids, the muscles of respiration, and others whose normal action depends on this function (§ 148). When this is generally and considerably impaired, the result will be fatal; because the respiration, deglutition, and other actions essential to life, suffer. It is by affecting these actions that apoplectic coma and narcotism prove fatal; and the state of sinking from excessive weakness or depressing causes, also exhibits the failure of the reflex power, when the urine and feces are voided involuntarily, and the breathing is irregular and gasping, being forced by voluntary effort. From failure of the same power, coughing and expectoration become inefficient in clearing the air-passages of mucus; hence the bronchial and tracheal rattles which precede death. As these movements are the last to fail, so, in recovery from asphyxia, syncope, and other similar states of partially suspended animation, the actions connected with the reflex function are the first to return with the restoration of life; and thus vomiting, coughing, and sneezing, are among the early signs of reaction. A failure of this function, similar in kind, but less in degree, is ex-

hibited in all states of extreme debility, whether from excessive fatigue or excitement (§§ 64, 65), or from directly depressing or sedative influences, as in adynamic fevers (§ 105). A person in this state is *too weak to sleep ;* for the medulla partaking of the general exhaustion, cannot maintain the respiration without assistance from voluntary efforts. Hence the feeling of oppression and the frequent sighing, which banish all repose ; or, if sleep do occur, it is disturbed by startings and fearful dreams, occasioned by the painful sensations of imperfect breathing.

155. *Remedial Measures.*—As with other instances of exalted nervous function, so with *excessive reflex action*, when dependent on inflammation, or determination or congestion of blood in the medulla, the remedies for these are appropriate against this effect; and the same measures in smaller degrees are often useful in hysterical affections, when these occur with fulness of habit and spinal tenderness. In case of irritation of the nervous centres, more purely nervous, as that of tetanus, hydrophobia, poisoning with strychnia, &c., a narcotic or sedative, which may lower the exalted function, is the desideratum. We possess some agents which efficiently reduce the power of the spinal system, and cause general relaxation of the muscles, such as hydrocyanic acid, woorara, Indian hemp, resin, and conium ; these drugs may themselves destroy life by arresting the function of the medulla oblongata in maintaining respiration ; but this very poisonous action, and the sedative effect which one (hydrocyanic acid) also has on the heart, render the remedy almost as dangerous as the disease.[1] For slighter irritation of the medulla, however, these medicines, in moderate doses, and a few others like them, are often beneficial. Thus hydrocyanic acid is a very efficacious remedy in vomiting, nervous palpitation, and hiccough ; it is likewise useful in convulsive cough, in which, however, the extracts of belladonna and stramonium are still more effectual, as they also are in spasmodic asthma. The same medicines and opium are often beneficial in relieving the spasms of colic, dysentery, and dysuria.

Some medicines, which act as stimulants to the heart and vessels, and to the cerebral functions, seem to operate as sedatives to the medullary system ; these are the stimulant antispasmodics ; such as ether, ammonia, musk, essential oils, gum resins, creosote, alcohol, &c., which are useful remedies in spasmodic and convulsive affections, in weak subjects without inflammation. They probably operate by giving vigor and equality to the circulation, and by preventing undue determination and congestion of blood in the nervous centres. External heat and counter-irritation act in a similar way.

There is another class of remedies which have some power in reducing the excitability of the spinal excito-motory system ; namely, tonics, especially those prepared from metals ; but the operation of these is gradual, and therefore probably indirect. The sesquioxide and other preparations of iron are efficacious in chorea, and perhaps in the more chronic forms of tetanus. Nitrate of silver, sulphate and oxide of zinc,

[1] From the late accounts of Dr. O'Shaughnessy and others, the resin of the Indian hemp seems to be more powerful than any other remedy in relaxing tetanic spasm, and in at least alleviating the symptoms of hydrophobia.

and sulphate of copper, have been found to diminish the attacks of epilepsy, hysterical convulsions, spasmodic asthma and cough, and other convulsive affections. The more obvious operation of these affections is on the vascular system, to which they prove astringent and tonic, and it is uncertain whether their beneficial action in nervous diseases is of this kind only, equalizing the circulation, or whether they exercise any more direct influence on the nervous system. The same question is open with regard to certain regiminal means which are effectual in reducing nervous excitability, such as cold bathing, country air, and change of air, and exercise. The latter, however, no doubt may be useful by exhausting the superfluous nervous power (§ 153) by another channel, voluntary motion.

The chief remedies to sustain *defective* or *failing* medullary function are stimulants, narcotics, and various strengthening measures. Thus a fatal state of sinking has sometimes been removed by the free administration of ammonia, ether, brandy, and other stimulants; and the best proof of their beneficial operation is when they procure refreshing sleep, which in itself is a source of renewed power. Narcotics would also seem to be indicated, but in an extreme condition of weakness their indiscriminate employment is hazardous, as they may paralyze the little remaining power, and lull the patient into the sleep of death. They should be preceded by, or combined with, stimulants; and those narcotics should be selected which have the least depressing action, such as opium. Other means must not be neglected to sustain the power restored by stimulants, especially suitable nourishment frequently administered in a liquid form.

REFLECTED, OR SYMPATHETIC SENSATIONS.

156. Clinical observation teaches us that not merely motory impressions, but those also which cause sensations, may be reflected, so that when the impression is made on one part the sensation is experienced in another. I do not allude to the fact that a stroke on the nervous trunk produces feelings referred to its branches, but I advert to impressions on the ultimate distribution of one nerve producing sensations in parts supplied by another nerve, or by another branch of the same nerve. The following are examples of this kind: Touching the external auditory meatus causes a tickling sensation in the glottis. A calculus in the bladder produces pain referred to the extremity of the penis. Ascarides in the rectum cause itching of the anus, and sometimes of the pudenda. Congestion of the liver sometimes is accompanied by pain in the right shoulder-blade; and a disordered state of the stomach, occasionally with pain in the left shoulder-blade. The pains of angina and gastrodynia often extend to the whole chest, and the former especially radiates to the left arm. Severe frontal headache is almost instantly caused in some persons by acid ingesta, in others by eating ice. Irritation of the intestines, as in cholera and colic (especially painter's colic), frequently causes pain and tenderness in the legs and feet, even when there has been no cramp or other excito-motory pheno-

mena. Temporary neuralgic affections, generally described as spinal irritation and cutaneous sensibility, seem to be due to similar causes.

In these and other instances that might be cited, the sensations cannot be referred to direct nervous communication, but to an influence reflected, probably, from the spinal centre only.

The sympathies subsisting between some organs are very remarkable, and none more so than between the breasts and the uterus. Applying the infant to the breast often induces uterine pains in women recently delivered; and the catamenial discharge has been excited in some instances by stimulating applications to the breasts.

157. The *remedies* most effectual in relieving reflected sensations are—1st, those that remove their irritating cause; and 2d, those that deaden sensibility (§ 137), anodynes. The peculiar efficacy of trisnitrate of bismuth and hydrocyanic acid in relieving gastrodynia and some kinds of angia, is, however, not explicable by any narcotic quality, and is probably due to an influence exercised on the power of the nerves to transmit sympathetic irritations. These morbid sympathies are often exalted in common with other nervous properties (§§ 126, 148), by weakness or irregularity of the circulation (§ 153); and are generally diminished under a tonic plan of treatment, especially with the metallic tonics, preparations of iron, nitrate and oxide of silver, sulphate of copper, arsenic, &c.

SECTION VI.

DISEASES OF SECRETION.

158. The power of secretion appears to be a vital endowment of the ultimate cells or molecules of secreting structures.[1] It is uncertain whether the process comprises the formation as well as the separation from the blood of the peculiar matter of the secretion. In the case of the urine and bile, it would seem that they may be formed in the blood without the aid of the secreting organs; for urea is found in the blood of animals whose kidneys have been prevented from acting by ligature of their bloodvessels, or by extirpation; and both urea and some of the principles of the bile (coloring matter and cholesterine), are found in the blood and in various parts of the body when the kidneys and the liver respectively have been disabled by disease. But whether the secreting structures assist in the formation, or only effect the separation of the matters which they eliminate, their elective power is equally a peculiar attribute of life, and is at present inexplicable by any physical or chemical law. I have, for the last twenty years,[2] advocated the opinion recently advanced by Dumas and Liebig, that the formation of the principles of the chief secretions takes place through chemical affinities,

[1] Müller, De Glandularum penitiori structurâ. Henle, Allgemeine Anatomie. Goodsir, Trans. Royal Society of Edinburgh, 1842. Bowman, Phil. Trans. 1842.

[2] In a thesis, *De Sanguine ejusque mutationibus*, Edin. 1824. See also Med. Gaz. September and October, 1835.

especially those of the absorbed oxygen and the constituents of the blood, controlled by vital agencies; but this view leaves still as a vital property the power which the liver has to separate bile; the kidneys, urine, mucous membranes, mucus, &c.

We are thus led to consider secretion as a peculiar property of the secernent structures, just as irritability is of muscular fibre (§ 110); and as such its disorder constitutes a primary element of disease. In doing this, we avoid the hypothesis of some physiologists, who ascribe secretion to nervous influence, a notion by no means accordant with numerous facts.

159. In reviewing the disorders of other vital properties, we have found that many of them are plainly referable to changes in the supply of blood to their respective textures (§§ 113, 127, 131, 133, &c.). The same cause may be found still more decidedly to operate in producing variations in the process of secretion. The blood being the material from which the secreted matter is supplied, variations in the quantity or quality of the blood will surely alter the quantity or quality of this product. Thus when an increased flow of blood takes place to a mucous membrane, its secretion is increased, and sometimes rendered more acrid than usual; whilst a congested state of the same membrane may impair the secretion. Hence the most common causes of altered secretion are those which operate on the sanguiferous system and its contents.

160. But affections of the nervous system, and of the mind, which acts through that system, may also influence the secreting process, as shown by the mouth watering at the sight or thought of a good meal; the bilious diarrhœa that mental agitation will cause in some persons; the large flow of limpid urine after nervous agitation; the tears excited by grief or other strong emotion; the unwholesome quality of a nurse's milk when she is in a state of anxiety or apprehension. We do not know whether these influences act by altering the flow of blood (§ 159), or by more directly modifying the vital property of the secreting organ (§ 158).

161. The importance of this element of disease may be estimated, from the ubiquity of the process of secretion, which includes both *excrementitious* (only to be voided out of the system), and *recrementitious* products (those concerned in digestion, assimilation, and nutrition), and also from the extent of its effects in relation both to the destination of the secretion, and to the blood from which it is separated. These may severally be EXCESSIVE, DEFECTIVE, AND PERVERTED.

162. EXCESSIVE SECRETION of any kind, whether bile, urine, mucus, &c., may weaken by the drain which it causes from the mass of blood (§§ 28, 71); and this effect will be in proportion to its quantity, and especially to the animal matter which it contains. Thus an excessive secretion of bile weakens more than that of thin mucus. But each secretion may have peculiar effects connected with its office and composition; and these effects may be *forwards*, on the parts to which the secretion goes, and *backwards*, on the organ which secretes it, and on the blood from which it is formed.

163. The *forward* effects of an excessive secretion of bile depend on its stimulating properties. It irritates the intestinal tube, causing a

bilious diarrhœa or cholera. The symptoms of this consist in an exaggeration of those properties of the alimentary canal which have already been described as elements of disease. Thus the bile irritating causes increased irritability (§ 113), and more rapid motion of the matter through the tube; pain from exalted sensibility (§§ 134, 135); vomiting, straining, and cramps, from exalted excito-motory function (§§ 149, 151); profuse mucous secretion from excited secernent function (§ 162). An excessive secretion of mucus in the intestines may cause only simple diarrhœa; but in the bronchi it may occasion dyspnœa and cough, and, if not expectorated, may suffocate. Excessive secretion in the stomach may cause pyrosis, or water-brash, the liquid being sometimes acrid, and may occasion nausea and vomiting, as well as eructation. The excessive discharges from secreting organs generally may amount to a flux, or profluvium; and those from internal inclosed serous surfaces or cellular texture, constitute various dropsies. These produce different effects according to their situation.

164. But excessive secretion may also have effects *backwards*, on the *organs*, and on the *blood* from which it proceeds. Excessive secretion often weakens the vital properties of the *organ*, so that, in its proper function, it subsequently becomes torpid. Thus after diarrhœa, the bowels often become torpid from defective secretion. So, too, in cases where an excessive secretion continues for a long time, it generally is impaired in its quality from a similar cause.

165. Excessive secretions, if abounding in animal matter, may not only reduce the mass of the blood, but also effect its composition. Thus bile and urine, which differ much in composition from the blood, if separated in unusual proportions, must leave the blood modified. Urine contains a great preponderance of azote; and its excessive formation from the principles of the blood would leave a predominance of hydrogen and carbon in this fluid. The bile, again, abounds in hydrocarbon, the copious removal of which would leave a superfluity of azote. It may be objected to this statement, that, according to the opinion of some chemists, the urine and the bile are not formed from the constant elements of the blood, but from materials derived from the food, and from the decay or transformation of the tissues. To this it may be replied, that this opinion is at present no more than hypothetical; and should it prove to be true, it would not affect the undoubted fact, that the secretions of the liver and of the kidneys are intended to balance one another, and the removal of carbon from the lungs; and that, whether the materials from which these eliminating processes are supplied be the principles of the blood itself, or the decayed constituents of tissues, or matters derived from the food, the co-operation of all these processes will be generally required to maintain a uniformity in the composition of the circulating fluid; so, too, if one of these processes is more active than the others, the blood must suffer by the excess of those matters which the less active processes allow to accumulate in it (§§ 68, 69). A clinical illustration of this position may be found in cases of bilious diarrhœa or cholera. This flux of bile is either accompanied by a highly loaded state of the urine, or by fever; in the latter case, the fever does not subside until the urine becomes very copious, or deposits an abundant

sediment. The most probable interpretation of this fact is, that the excessive secretion of bile disorders the composition of the blood; so long as the kidneys rectify this disorder by separating in greater abundance the solid contents of the urine, no fever results; but if the kidneys fail in this task, fever ensues, and continues until they accomplish it; then a free secretion and copious deposit are symptomatic of the decline of the fever.

166. The *remedial measures* that are serviceable in cases of excessive secretion, well illustrate the view that has just been given of the balancing office which the secretions all fulfil. In so far as excessive secretion is dependent on the quantity and quality of the blood (§ 159), the treatment should be addressed to this element; by depletion, derivation, and evacuation, in cases of congestion or determination of blood; and in such cases, the excessive secretion should not be hastily checked, as it may be a natural means of relief; nay, in some cases, it may be most speedily arrested by means which for the time increase it; thus a large dose of calomel will sometimes, after first purging, stop a bilious diarrhœa connected with an engorged liver, which astringents fail to check. But where the excessive secretion proceeds more from nervous and other sources of irritation (§ 160), and causes weakness and disturbance of the functions, it becomes a more immediate indication to check it. Secretions are to be diminished by means which act as general tonics or astringents (§ 124), and by others which operate only on particular organs. Of the former class are cold applied to the part, and common astringents, such as alum, superacetate of lead, sulphates of zinc and copper, gallic acid and tannin, and substances which contain them, as nutgalls, oak bark, rhatany root, catechu, &c., mineral acids, &c. These act most surely by direct application, as in their use for diarrhœa, leucorrhœa, &c.; but they seem to have some effect also through the medium of the circulation, as, when taken internally, they reduce the secretion in the air-passages and skin. Of the agents which, without a general astringent effect, more specifically diminish the secretion of particular organs, may be mentioned opium, which remarkably lessens the secretion of the liver, and sometimes that of the kidneys.

If an excessive secretion have already caused febrile disturbance, great advantage will be found to result from the use of means which increase other secretions, and thus restore the balance before explained (§ 165). Thus in bilious cholera, saline diuretics and diaphoretics are highly serviceable. In renal irritation, with copious secretion of lithic acid, blue pill, which augments the secretion of bile, is often beneficial. These means may be supposed to operate partly as derivants; but the manner in which they remove the febrile irritation, after the reduction of the excessive secretion, renders it most probable that they act also by removing from the blood dregs left by the inordinate separation of the matter of the single secretion which has been in excess (§ 165). No practical physician can doubt that we possess medicines which often augment the secretions of particular organs (mercury, that of the liver and salivary glands, colchicum that of the kidneys, &c.), yet there is a limit to the operation of these agents; but this limit may be increased by simulta-

neously acting on other organs which maintain the balance. Thus in any disturbance of the secretions, especially if it continue long, combinations of medicines are much more useful than those fulfilling one indication only; and thus experience has sanctioned the practice of conjoining mercurials with diuretics, and antimonials with salines, &c.

167. Secretions may become DEFECTIVE in consequence of a weakened state of the whole circulation, or of that of the secreting organ, as in the case of exhaustion from previous excitement (§ 164). Or they may be impaired by depressing influences which paralyze the vital powers, as in the case of morbid and narcotic poisons (§§ 56, 64, 65); or they may be checked by agents which increase the tonic contraction of the vessels of the part, as cold (§ 77) and astringents, or of the whole sanguiferous system, as in the case of the hot stage of fevers (§§ 85, 421).

Defective secretion of any natural or habitual discharge (§ 70), may cause a fulness of the bloodvessels; a general fulness, if the secretion be naturally copious; a local fulness, if it be trifling in quantity. Thus defective secretion of urine or bile may cause general plethora, or extensive local congestions, which may end in dropsical effusions, fluxes, hemorrhages, or inflammations. Diminished secretion of tears or saliva would merely cause fulness and dryness of the parts immediately concerned.

The morbid effects of defective secretion may be both *forwards*, on the parts for which the secretion is intended, and *backwards*, on the organ and on the blood from which it should be eliminated (§ 162).

168. Defective secretion of bile causes disorder in the latter stages of digestion. The neutralization of the acid in the chyme, and the separation of the chyle, to which the bile seems to contribute, are imperfectly performed; sometimes colic and diarrhœa, sometimes costiveness, result from the defect. Deficient secretion of mucus in the intestinal canal and bladder would expose their membranes to more irritation from their contents. Probably deficient secretion of mucus on the respiratory membrane may lessen the facility with which the air and the blood act on each other. Insufficient secretion of cerumen in the ear, or of saliva in the mouth, impairs respectively the hearing and the process of mastication. A want of synovia in the joints, has been supposed to be a cause of their imperfect motion and subsequent inflammation.

169. The effect of defective secretion in causing congestion of its respective organ, has been already noticed; the concomitance of congestion with defective secretion, in the case of the liver, the kidneys, and mucous membranes, is well known; but either may be viewed in the light of both cause and effect.

170. The most remarkable of the *backward* effects of defective secretion are instanced in case of the excretions (§ 70). The distinctive materials of the secretions of urine and bile appear to be positively noxious, and poison the system if not separated from the blood. Thus the sudden suppression of urine or bile causes typhoid symptoms, extreme depression, and coma, which speedily end in death; and in such cases, urea, or the coloring matter of the bile, has been found in various organs. Where the suppression is incomplete, the poisoning process is

more tardy; various functional and visceral derangements are produced, such as delirium, or lethargy, dyspnœa, palpitation, vomiting, diarrhœa, dropsical effusions, structural degenerations, &c., which always cause injurious effects, if the defective excretion be not restored. But the amount of these effects will depend on the extent, and especially on the suddenness, of the diminution of the excretion; and it is very remarkable when it is very gradual, how little disturbance it may for some time induce. In these gradual cases, still more remarkably than in those of more sudden suppression, some of the excrementitious matters may be detected in the blood and in other fluids and solids of the body. Thus in some structural diseases of the liver, the color of the bile becomes manifest, first in a yellow, and by accumulating in a deep greenish color in all the textures, constituting the yellow and the black jaundice. In granular degeneration of the kidneys, in which scarcely any urea is excreted by these glands, this principle is found in the blood and various fluids of the body. In the case of a patient of mine, affected with ascites from disease of the heart, liver, and kidneys, Mr. Garrod obtained nearly four grains of nitrate of urea from an ounce of the peritoneal fluid, and a considerable quantity of bright yellow solid matter, probably bilious. In other cases, I have known the fluid of ascites and anasarca from diseased kidneys, emit a decidedly urinous smell, and exhibit on analysis easily appreciable quantities of urea. One of my pupils, Mr. Palmer, detected urea in the serum contained in the ventricles of the brain, in a case of fatal apoplexy from granular kidneys and diseased heart.

171. The excretions are defective in many idiopathic and symptomatic fevers; and there can be little doubt that many of the constitutional effects of these fevers are in great measure due to this important element. The positively noxious properties which excrementitious matter retained in the blood is known to possess (§ 170), must be taken into account when we attempt to explain the states of constitutional irritation and depression, with perversion of functions, which fevers so generally present. [One of the most interesting facts connected with the pathology of the epidemic fever which prevailed in Edinburgh in 1843, was the discovery of urea in the blood and serous fluid of the ventricles of the brain, in some of the patients affected with cerebral symptoms. "The existence of urea in the blood," says Mr. M. W. Taylor (*Scottish Med. Gaz.* p. 281), "in other cases, has been inferred from the occurrence of disorders of the nervous centres, which we know to be the consequence of its undue accumulation in the circulation. These phenomena have been observed in those cases in which, from some cause or other, the daily discharge of urine has undergone material diminution."[1]—C.] The changes in the blood, manifest in some such cases by its fluidity and by petechial appearances, may also be in part referred to defective elimination of effete matter;[2] and it is when the secreting organs recover their power, and a diarrhœa occurs, or a copious discharge of highly loaded

[1] [Clymer on Fevers, p. 92, Phila. 1846.—C.]

[2] Purpura I have found to be often connected with hepatic congestion, and imperfect excretion of bile, and to be most effectually removed by remedies which promote the restoration of the proper secretion.

urine, that these appearances cease. It is very probable that severe mechanical injuries or shocks (§ 52), and animal and other poisons (§§ 85, 105, 57, &c.), operate by thus injuring the vital powers by which the blood is continually purified from its own noxious products; and that this is a part of their mode of action, seems almost certain from their effect in suppressing or impairing the natural excretions. Accordingly, in such cases, urea has sometimes been detected in the blood.

There can be little doubt that a morbid element, which in its extremes acts so injuriously as to cause serious disorder, and even speedy death, must in slighter degrees be an important cause and constituent of disease; and I believe that gout, rheumatism, and many cachectic states leading to diseases of nutrition, degenerations, dropsies, &c., are essentially connected with defective excretion.

172. *Remedial Measures.*—Defective secretion may be caused by deficient or excessive supply of blood to the part, as in various cases of anæmia, congestion, and inflammation (§ 159). In such cases it must be treated by the proper remedies for these conditions; thus stimulants may restore secretions scanty through a defective supply of blood; and depletion and derivation may be the best remedies, when they are stopped by inflammation or congestion.

173. But sometimes the first disorder is in the secreting structure itself (§ 158), and may best be removed by agents which specially increase the respective secretions, which common stimulants will not do. Thus mercury increases the secretion of the liver; colchicum, nitre, and other diuretics, that of the kidneys; croton oil, jalap, sulphate of magnesia, and other purgatives, that of the intestines; and this they do, however introduced into the system, whether by the mouth, through the skin, or injected into vessels or textures. These are important practical facts, however difficult they may be to explain; and their application to restore defective secretions is abundantly obvious.

174. But these specific stimuli of the secreting organs (§ 173), if used in excess, or too long, may not only cause general weakness, but also exhaust the vital properties which they excite (§ 159); and the result may be a diminution either of the secreted fluid, or of its most characteristic constituents. Hence the long or excessive use of mercury causes torpidity of the liver; that of purgatives, imperfect action of the bowels; that of diuretics, scanty urine, or albuminous or watery urine, defective in urea. These facts point out the expediency of intermitting the use of these agents, and of alternating or conjoining them with others calculated to improve the vital properties of the textures generally, which may often be effected by the medicines called tonic, and by regiminal means which improve and equalize the state of the circulation (§ 124), and preserve the digestive and assimilative functions in the best order. In illustration of this position, I may refer to the acknowledged advantage of giving bitters with or after mercurial courses; chalybeates with or after saline aperients and diuretics, when these are long used; and these additions, which alone, or used at first, would check the secretion to be increased, now sustain it and render it permanent. Some medicines which are inferior in efficacy to those already named, are yet, in some instances, more eligible for chronic cases of defective secretion; because

they are less exhausting, and combine some measure of tonic influence with that of increasing the secretions. As examples of this kind may be named taraxacum, preparations of iodine, sarsaparilla, nitric, and nitro-muriatic acids. Courses of these medicines are sometimes of great efficacy in keeping free the secretions after they have been restored by more powerful means (§ 173); and they likewise often improve the functions of digestion and nutrition.

175. Where defective secretions are not readily restored, the *forward* disorder (§ 168) arising from their deficiency, may be sometimes compensated by artificial substitutes. Thus, in defective secretion of bile, the action of the intestines has been promoted by exhibiting ox gall. Aloes and soap combined have been thought to supply the place of bile in some cases. Toasted bacon at breakfast has been supposed to have a similar effect; but it more probably excites the liver to increased secretion, as other fat matters do. Imperfect lubrication of the throat and larynx, and other mucous membranes, from defect of mucus, may be remedied by mucilaginous and demulcent matters. A dry state of the skin may be relieved by applications of oil or honey.

176. Perversion of secretion often accompanies excess and defect of this process. In febrile diseases, the secretions of the kidneys and alimentary canal are altered as well as diminished. Inflammation and determination of blood change as well as increase the secretion from mucous membranes, rendering it more saline, and sometimes albuminous. The urine exhibits remarkable changes in quality; full living, stimulating beverages, and irritations of the digestive organs or kidneys, rendering it unusually strong and acid; whilst low diet, and other causes of weakness, generally make it pale and alkaline. Out of these morbid conditions may arise various further decompositions, with sediments and calculous concretions of different kinds (§§ 51, 53). Concretions are likewise formed from an altered state of the bile. The alvine secretions are greatly modified by various febrile and cachectic diseases, being altered in color, and unusually offensive in odor. The perspiration is also sometimes changed; thus it is very acid in rheumatism, and fetid in delirium tremens.

177. Secretions which serve particular purposes, when altered may become unfit for these, and thus cause disorder; thus a thin acrid mucus irritates, instead of protecting, the membrane which secretes it, as in coryza and mucous diarrhœa; a viscid dry mucus clogs up and obstructs tubes which it was intended to lubricate; altered gastric juice causes indigestion; sebaceous matter of the skin may accumulate in its follicles, and cause irritation and inflammation, &c.

178. The *remedies* for perverted secretions (§ 176) are usually those which likewise increase secretion (§§ 172, 173). Thus depraved secretions of the intestinal canal are often satisfactorily altered by continued purging; a turbid state of the urine is sometimes removed by diuretics; too thick a state of the mucus of the air-passages is modified by expectorants, &c. But where the change depends on altered circulation in the part, the remedies must be suited accordingly. In some cases, tonics restore a healthy state of secretions; and in most instances of long-con-

tinued perversion, tonics may be advantageously combined with medicines which increase secretion (§ 174). Such a combination is presented in most of those remedial agents which have obtained the appellation of *alteratives*, and which would seem to be especially suited to oppose the diseased element under consideration, if they really possessed the virtues ascribed to them.

Nutrition is also effected by the property of secretion (§ 158); but inasmuch as its changes cannot be understood without a previous knowledge of the blood and its constituents, and involve the complex subject of structural disease, their consideration will be deferred.

SECTION VII.

DISEASES OF THE CONSTITUENTS OF THE BLOOD.

179. The pathological elements (§ 107) which we have hitherto considered, are those of the vital properties of the elementary solids. We now proceed to examine the morbid changes of the blood. These, like those of the solids, may be often traced to individual elements, of which the blood is composed, the changes of which must be viewed as ultimate elements of disease, and are therefore properly included in the present division. But as the blood also operates as a whole, compound, indeed, in itself, but simple in its influence, on vital functions and structures, it forms a proper connecting link between *ultimate* and *proximate* elements of disease. So, also, inasmuch as it is in some respects an organized compound, the materials of which are changed, together with its functions, and contributes to the production of change of structure in the solids of the body, the consideration of its changes will be a proper introduction to that of alterations in the circulation, which induce change of structure, and thus lead to structural diseases themselves.

180. We have found that blood is the support of all the vital properties; and in describing their variations, we have been obliged to refer frequently to differences in the supply or quality of this fluid, both as causes and as consequences of these variations (§§ 113, 127, 131, 159, &c.). We have now to examine the properties of the blood itself, and, first, those which are most elementary, or referable to its respective constituents.

The circulating blood consists of red particles, colorless globules, and liquor sanguinis; but as the latter is compound in function as well as in constitution, it is necessary to specify its chief constituents. We have, then, to consider—

1. The red particles,
2. Fibrine and colorless globules,
3. Albumen and other dissolved animal matters,
4. Oil,
5. Salts,
6. Water,

in excess, defect, and alteration.

181. The average natural proportions of the chief constituents of the blood, according to Lecanu, and adopted by Andral and Gavarret as a standard, are 127 red globules; 3 fibrine; 72 animal matter in the serum; 8 salts; 790 water.[1]

RED PARTICLES.

182. The red blood-disks appear to be the part of the blood on which its vivifying and calorific properties chiefly depend. Thus Prevost and Dumas found that animals bled almost to death could be restored by injecting into their veins a mixture of red particles and serum, even when the fibrine had been removed; yet the serum alone failed to produce any such effect. It is therefore to be supposed that the red particles are the part of the blood required in transfusion in cases of hemorrhage. Andral, Gavarret, and Delafond, remarked that, in domestic animals, the vigor and beauty of the animal were proportioned more to the amount of red particles in the blood of the animal than to any other constituent; and that improvement of a breed by crossing was marked by an increased proportion of this element.[2] The red particles are supposed, by Liebig, to be the means by which oxygen is carried throughout the circulation, and brought to act on the various textures. Their proportion varies considerably in health; in men, it may be stated generally at from 120 to 140 in 1000 of blood; in females, it is usually from 10 to 20 less. They are most abundant in early adult age, and are in rather smaller proportions at earlier and later periods. In the fœtus, however, they exceed the amount in the maternal blood (in the proportion of 222 to 140, Denis), and this preponderance is retained for some weeks after birth, until, in fact, the blood becomes more watery.

183. *Excess of the red particles* might, therefore, be expected to cause a general excitement of the vital properties of the body (§ 182). Accordingly, Lecanu found that they exist in larger proportion in persons of sanguine temperament (§ 38), than in others, and especially in those of vigorous constitution. Andral and Gavarret detected a slight increase of them in some cases of the early stage of inflammations and fevers, especially eruptive fevers, as measles and scarlatina. In sanguineous plethora, and in hemorrhagic diseases before much blood is lost, they were in excess, in some instances rising to 185 in 1000 of blood. The obvious sign of the abundance of red particles is the florid color apparent in the lips, cheeks, gums, and other vascular parts; the deep blue color of the superficial veins; and the fine deep crimson which a thin film of blood gives on a white plate. The bodily functions, animal heat, and muscular irritability are in an exalted state, bordering on or passing into febrile excitement. Judging by these indications, we may often predicate the existence of an excess of red corpuscles in those accustomed to good living, with such an amount of exercise in the open air as suffices to keep the digestive and assimilative functions in an active state.

[1] Annales de Chimie et Physique, Nov. 1840, p. 229.
[2] Ibid. Juillet, 1842.

185. The *red particles are defective* in persons of the lymphatic or leucophlegmatic temperament (§ 40); after great losses of blood (artificial or from disease); in chlorosis, and in other anemic states, as those connected with advanced stages of cancer, diabetes, scurvy, and other cachectic diseases; in scrofulous and tuberculous diseases; in the latter periods of fevers, and after severe inflammations; in granular degeneration of the kidney, and other organic diseases, especially when attended with dropsy; in diseases of the spleen, and others of malarious origin (§ 85); in cases of slow poisoning with lead; and in persons inhabiting dark and ill-ventilated abodes. In an extreme case of chlorosis, the proportion of the red particles was found by Andral, reduced to 27 in 1000 of blood.

The signs of the defect are, paleness of parts naturally colored with blood, pallid or sallow hue of the skin, pink color of superficial veins, and a pinkish or light purplish hue of a film of blood on white plate. The symptoms of such a condition are those which will be more fully described under the head of anæmia; a weak state of the functions generally, of circulation, calorification, digestion, and nutrition, constituting their summary.

[The maximum attained by the red corpuscles in health is 140, whilst the minimum is 110 in 1000. Force and strength of constitution are the condition of the economy favorable to the former, and feebleness, congenital or acquired, to the latter. Sanguine losses, and deprivation of food, produce, as a constant effect, diminution in the red corpuscles, whilst the fibrine, as we shall see, is less constantly and necessarily influenced by these causes. Diminution in the quantity of the red corpuscles may exist as an independent morbid state, or may supervene as an epiphenomenon in other diseases. In 24 cases of confirmed spontaneous anæmia, the mean of the red corpuscles was 64 (Andral). In the cachectic condition resulting from the poison of lead, so well described by Dr. Tanquerel, the red corpuscles fell to the same mean as in spontaneous anæmia, whilst the other materials of the blood remained unaltered. Certain modifications in the organism may influence the blood, and diminish the quantity of the red corpuscles. This occurs ordinarily in pregnancy. In the neuroses, the blood is remarkably poor in red corpuscles; in phthisis, there is diminution of this constituent, as well as in all chronic organic diseases.—C.]

186. *Alterations of the red particles* are evinced by changes in the color of the blood, and in the form of the individual corpuscles, as seen by the microscope. The coloring matter is evidently *altered* in some diseases, being much darker than usual, as in the worst forms of scurvy, in which the blood is said, by Mead, to be changed to a dark-brown or green color; in the Walcheren and other malignant fevers, it has been described as pitchy black. In the worst forms of cachexia (or rather cachæmia), from malarious influence, generally in conjunction with disease of the spleen, the blood is not only very poor, but perverted, exhibiting various shades of purple, brown, and even greenish colors. Some change seems to occur in congestive typhoid fevers, in which the bloodvessels become stained or dyed of a deep claret color; this imbibition implies a breaking up and unnatural solution of the red particles.

Probably the occurrence of petechiæ and ecchymosed patches in these diseases is partly dependent on a similar change. The readiness with which the textures become stained in scorbutus, in jaundice, and albuminuria, and in secondary syphilis, seems to indicate an alteration in the coloring matter; inflammations and ecchymoses in the skin being commonly followed by livid, purple, or copper-colored stains. The yellow tinge of the skin in yellow fever, occurring chiefly along the course of the chief bloodvessels, the peculiar sallowness connected with diseased spleen and in chlorosis, and the dark discoloration around the eyes in the same diseases, apparently proceed from a change in the coloring matter of the blood, which causes it to escape from the vessels and tinge the skin like in a part discolored by a bruise. The black matter of melanosis seems to be derived from the coloring part of the blood in an altered state; this is certainly true of the spurious melanosis of the intestines.

187. Besides changes manifest in the color of the blood, the red particles are subject to alterations in their form, size, and other properties in connection with the medium in which they are placed. It was first observed by Hewson, that pure water causes them to swell, become globular, and burst; whilst saline solutions, containing more salt than serum does, make them shrink in size. These changes are now generally understood to arise from endosmosis and exosmosis; the saline matter drawing the water into or out of the little cell, which, with its contained coloring matter, constitutes the red particle. It is highly probable that similar changes may take place in the living body, from circumstances which greatly alter the proportion of saline matter and water in the blood. May such change contribute to produce the serious symptoms, and even sudden death, which have ensued on drinking a large quantity of water after great exertion? Has it aught to do with the reaction and irregular excitement sometimes occurring after excessive losses of blood? Or with the symptoms of suffering which animals manifest at the instant of injecting water into their veins? Dr. Owen Rees has suggested that the remarkable diminution of the blood-disks in cases of albuminuria, may be due to their destruction, in consequence of the draining away of albumen from the blood, and thus reducing it to a very watery state; and the same circumstance may prevent their redevelopment from the chyle and lymph both in these cases and in chlorosis. In several cases of Bright's disease of the kidney, I have observed the blood-disks jagged or crenate at their margins, and otherwise imperfect; and the same remark has been made by Simon of Berlin and others, and by Andral in a case of chlorosis. [In two cases of chlorosis, Andral found the red corpuscles smaller than usual, and many of them altered in form, appearing in the field of the microscope as if broken into fragments. A young girl whose blood presented this appearance, became, after two months of appropriate treatment, plethoric; and, at this interval, on the globules being examined, they were found in a perfectly healthy state. In an epidemic typhus which prevailed in different districts of Italy, in 1841, M. Renzi, of Naples, states, that the red corpuscles were readily freed of their coloring matter, seemed to have lost their central nucleus, and were altogether less compact and

solid than naturally. In the Edinburgh epidemic fever of 1843, on examining the blood of a number of patients, Prof. Allen Thompson and Dr. Cormack found the red corpuscles serrated and notched.[1]—C.] In one fearfully rapid example of albuminuria, which proved fatal in six days, with effusion of pus in the joints the day before death, I found the coloring matter dissolved in the blood-liquor after death, and scarcely any red disks remaining. There were numerous pus-globules in the blood. A similar total destruction of the blood-disks was observed in University College Hospital, in the blood of a person who died of malignant scarlet fever with purpura. I have met with similar proofs of breaking up of the red particles, but to a much smaller extent, in acute purpura connected with jaundice, and in cases of disturbed function of the liver without jaundice; is this due to the remarkable solvent power exercised by small proportions of bile on the red particles, noticed by Simon and others?

188. The change of the blood from dark to florid, on the addition of saline matter, appears to depend on the increased density and distinctness given to the red particles, and to the colorless globules, whereby they reflect light more abundantly, and are also rendered less transparent.[2] Probably the action of oxygen in reddening venous blood, is of a similar character, for it also renders the blood less transparent. This explanation of the color of arterial blood was suggested to me by some experiments which I made in 1835, and in some measure corresponds with the opinion of Dr. Wells,[3] that the brighter color is due to fine mechanical division. Dr. J. Davy, in 1838, expresses a like conclusion. More recently, Mulder's notion, that the florid color of the arterial blood is caused by the formation of a film of solid deutoxide of proteine on each particle, implies a similar explanation of the physical cause of the bright color, which he farther shows not to depend on any change in the coloring matter itself; but his explanation will not apply to the more rapid and complete brightening of blood by saline matter. I have noticed that the dark fluid blood found in the body in malignant scarlatina, and other bad congestive fevers, does not redden so soon as usual on exposure to the air. The same remark applies to some of the cases of altered red particles mentioned above (§ 187).

189. The red particles are distinct structures, living cells, or celliform nuclei (Wharton Jones), although isolated, and floating in a lifeless fluid. Like other living cells, they probably possess the power of secretion; but what they secrete, whether fibrine or the peculiar principles of the excretions, has not been ascertained, and we can, therefore, say nothing of their modifications. It has been conjectured that they have other vital properties, such as spontaneous motion, and attractions and repulsions; but there are no unequivocal facts in support of such notions. The motions described by Treviranus, Schultz, and others, may be accounted for on purely physical principles. It is said, that a systolic and diastolic movement in blood-particles has been observed, by Dr. Martin Barry, in the Fallopian tube of a recently impregnated rab-

[1] [Clymer on Fevers, p. 91, Phil., 1846.]
[2] Medical Gazette, Sept. 1835.
[3] Phil. Trans. 1795.

bit; but this seems to have been an effect of the movements of the cilia of the membrane.

190. Hewson, Prevost, Dumas, and others, observed that the red particles of new-drawn blood cohere together in piles or rouleaus. This cohesion in healthy blood is of very short duration; for it has been remarked by Dr. Hermann Nasse and Mr. Wharton Jones, that in a few seconds, the disks may be seen loose and confused; but in blood drawn from a person affected with inflammation, the cohesion takes place earlier, is more firm, and lasts longer than usual; and they consider this the chief cause of the separation of the red particles from the fibrine, which constitutes the buffy coat. We shall notice the relation of this phenomenon to the buffy coat under the head of *fibrine;* but of the cohesion of the red particles, we would remark, that it is not certain that it is more than one of mechanical aggregation modified by changes in the relative dilution of the liquor sanguinis, without and within the blood-corpuscle. The even momentary exposure of so thin a film of blood to the air causes evaporation, which affects the serum before it can reach the interior of the blood-particles. At this time, they cohere; but the exosmosis proceeding from the individual particles, soon again detaches them from each other.[1] But, without dwelling on this or the equally hypothetical notion that the cohesion is due to a vital attraction, it is not unimportant to observe this property, and the variety which is presented in inflammatory disease. It has been supposed that a similar aggregation of the blood-corpuscles occurs within the bloodvessels, and is the cause of obstruction in the capillaries in inflammation and other cases of impeded circulation. But no regular or firm cohesion is seen in the large vessels of a frog's web, when the motion of the blood is arrested by pressure on a vein; and although the blood-disks do accumulate and cohere in some of the vessels of an inflamed part, this will be hereafter shown to be due to an obstruction by the colorless particles. (See INFLAMMATION.)

191. There is still much doubt with regard to the origin of the red particles; and there is a corresponding uncertainty as to the essential seat and mode of their increase. It is most probable that their development and growth, as well as their decay, take place throughout the sanguineous system, but are most favored by the changes to which they are exposed in the great depurative organs, the lungs, liver, and

[1] Hence, as it has been remarked by Mr. Gulliver, the addition of a little salt prevents the cohesion of blood-disks. I do not assert that there is nothing vital in these properties exhibited by the organized parts of the circulating fluid, but I must protest against the hasty assumption made by some physiologists, that the motions and alterations revealed in animal and vegetable fluids by the microscope, are all dependent on a mysterious vitality. If any microscopical observer will take the trouble to watch the behavior of any light flaky precipitate recently thrown down from a solution in water or spirit, he will see motions and aggregations as remarkable as those of the recently effused blood-disks, although less regular from the unequal size and shape of the particles. The close and orderly arrangement of the blood-disks is favored by their mobility and flatness, which facilitate the operation of the aggregative force; and in this respect, they contrast with the white globules, whose globular shape and larger mass render them less apt to coalesce; they, however, often form centres, around which rolls of disks cluster in circles or rays. It is remarked by Mr. Gulliver, that the elliptical particles of reptiles and camels cohere together in irregular heaps, without the rouleau arrangement seen in the round disks, which is therefore the more probably due to their mechanical properties.

other glands. Whether they originate in the organic globules of the chyle and lymph, or from the granules of the white corpuscles, or from both, is quite undetermined; but such an origin appears more in accordance with observed facts than their supposed multiplication by the division of the old disks. Their increase is intimately connected with an active state of the organs concerned in general nutrition, especially where their formation is favored by a supply of the ferruginous material which forms a distinctive feature in their composition.

The influences which promote the decay and retard the formation of the red particles (§§ 185, 186), are chiefly those which impair the nutrition of the body; but there are some which affect the red particles much more than they do other components of the body. Two of the most remarkable are a diseased state of the spleen, and disordered uterine function. The striking pallidity, or pale sallow hue of persons who have been long suffering from malarious influence, more particularly in warm climates, has often attracted attention; but it is now generally considered that these are cases in which the spleen has become diseased, an acknowledged result of the continued operation of malaria. The state of the blood in these affections has been noticed (§ 186); and it may be farther explained that a diseased spleen operates not only by withdrawing from the circulation an undue proportion of blood, but, by keeping it in a stagnant state, unrenewed and unpurified by the processes of circulation and excretion, it *spoils* the blood, and renders it unfit for farther use. Hence, when in lapse of time, and under changes of circulation when portions of this spoilt blood are again rendered into the vessels, they corrupt and contaminate the whole mass, and induce the various kinds of cachæmia or cachexia which form the sequels of malarious diseases. This view accounts for the fact, often considered unintelligible, that such remarkable effects result only from enlargements of the spleen, and not from its entire obliteration, which has been repeatedly noticed to occur without any peculiar effect on the blood. Other instances of a similar character will be mentioned under the head of *congestion.*

The mode in which amenorrhœa tends to impair the quality and quantity of the blood-particles, may also derive some light from the foregoing remarks. A young female, during or before menstruation, is exposed to continued cold, or sudden mental excitement; the discharge is checked; and if no serious illness immediately ensues, she begins to fade, and in a few months becomes chlorotic. The uterine system remains congested after the repression of the discharge; and the blood in the system suffers not only from the interruption of a process of excretion (M. Gay Lussac and Andral have proved it to be such), (§ 170), but also from a reservoir of impure blood, which tends gradually to derange and contaminate the whole mass.

192. *Remedial Agents.*—Excess of the red particles may be speedily removed by bloodletting, which reduces these much more than the other constituents of the blood. Low or vegetable diet, and the antiphlogistic regimen generally, including the avoidance of all stimulating or exciting agencies, produce a similar effect more tardily. It is not certain whether any medicines directly act in a similar way; but cholagogue purgatives,

and probably the continued use of mercury, colchicum, and other medicines which largely increase the excretions (§ 173), ultimately reduce this element. Mineral saline waters, and saline medicines, very copiously taken in a state of much dilution, sometimes reduce extreme rubicundity of the surface in so remarkable a degree as to suggest the notion that, by their absorption into the mass of blood, they may directly destroy some of the red particles; they are, therefore, useful cooling agents where these are in excess. The remarkable pallidity which accompanies the occurrence of extensive suppuration, would also point to the formation of pus as a means of diminishing the red particles, which means may be used artificially in the form of setons and suppurating counter-irritants.

193. To *promote the increase* of the red particles, *where defective*, we might expect nourishing food, especially brown meats, exposure to invigorating air and light, and tonics generally, to be the proper means. But without experience, we could not have anticipated that medicines containing iron should possess such remarkable efficacy in relation to this element of disease. In many cases of chlorosis, under the use of any suitable preparation of iron, the complexion will change from waxy to ruddy, in three or four weeks' time. In the choice of the preparation of iron to accomplish this purpose, we must be guided by the state of the stomach and other considerations, but where they are borne, the most soluble preparations are the most effectual; and this is of more importance than the particular combinations in which they are administered; thus the iodide, sesquichloride, sulphate, citrate, acetate, and phosphate, are all eligible. This subject will again come under our consideration in connection with anæmia.

It has been supposed by Dr. Stevens that saline medicines have great power in restoring to their natural condition the red particles which are changed in typhoid and malignant fevers (§ 186); but if these remedies have any power in such maladies, it is very doubtful how much is to be ascribed to this mode of action. A less questionable mode of restoring the proper condition of the blood-particles, is by promoting the elimination of those diseased, by increasing the excretions (§ 192); whilst the multiplication of others is aided by the means noticed above (§ 193). Thus, in malarious and anæmic cachæmia, the best effects result from the combined use of purgatives and diuretics with chalybeate tonics. The disposition of the red particles to coalesce, which is augmented in inflammation, may be diminished by the addition of saline matter; and Mr. Gulliver has surmised that this may be a part of the useful operation of saline medicines in inflammation.

SECTION VIII.

FIBRINE AND WHITE CORPUSCLES.

194. The trifling difference in chemical composition between fibrine and albumen (a minute predominance of nitrogen in the first, Dumas),

would scarcely distinguish them; but the organizable property of fibrine is that which makes the distinction obvious, and most important in physiology and pathology. Being the constituent which causes the coagulation of the blood, with all the varieties which that process exhibits; being the part which constitutes the buffy coat and coagulable lymph; and being probably the material by which textures are chiefly nourished and repaired, its changes must constitute an important element of disease. Although probably not so immediately concerned as the red particles in maintaining the vital processes of respiration, circulation, and innervation, it is yet a representative of the active state of these processes, and of the nutritive and reparative function; and it therefore exists in larger proportion and higher perfection in arterial than in venous blood. Although, as above stated, it is distinguished from albumen less by chemical differences than by organizability and susceptibility of life, yet there are certain conditions, both chemical and physical, favorable to the formation of fibrine, through a knowledge of which we are able to influence artificially its production. Fibrine, as presented to us in the washed clot, coagulable lymph, or the buffy coat of inflamed blood, consists of a congeries of extremely fine fibres, with transparent granular bodies, separate and in round encysted clusters scattered through them. In fluid blood, we see the same encysted clusters or pale corpuscles, but none of the fibres. The formation of these *fibres* seems, then, to be the great characteristic of fibrine, and its power to assume this form of solid, distinguishes it from albumen, which solidifies in a granular mass. So long as fibrine remains dissolved, as in the blood liquid, it has nothing to distinguish it from the albumen with which it is combined, but it still has the inherent capacity to solidify in a peculiar manner. This capacity, from the time of J. Hunter to the present, has been generally considered to be an attribute of inherent life; and undoubtedly it is connected with vital activity in the sanguiferous functions; but various facts, particularly some pointed out by Dr. Buchanan, of Glasgow, and Mr. Gulliver, show that the fibrillation of fibrine, like the crystallization of a salt, is much promoted by, and sometimes dependent on, the presence either of fibrine already solid, of the pale corpuscles, or of some kindred solid matter. Exposure to the air, and dilution with water, also favor the consolidation of fibrine. The former is probably also instrumental in its production; for the circumstances which promote the formation of fibrine in the blood, generally include a certain degree of increased oxygenation. In fact, according to Mulder, fibrine is chemically an oxyproteine, or, more definitely, the deutoxide of proteine.

But although fibrine can be thus designated according to its mere chemical and physical nature, we must not lose sight of the peculiar relation in which it stands to vital properties, which attach themselves to it more than to any other constituent of the blood. Its fibres, cells, and granules may be regarded as the rudiments of new living textures, and in observing its mechanical construction and its chemical constitution of deutoxide of proteine, we only note the conditions of a most highly animalized material, which render it fit for the peculiar properties of life.

The average proportion of fibrine in the blood of a healthy adult is

about three in a thousand parts. Within the limits of health, it may vary from one and a half to four and a half, being more abundant during advancing growth in well-fed persons with active circulation; and less so in early infancy, and in persons of weakly constitution and advanced age.

195. An *excess of fibrine*, and of the colorless globules (hyperplasma, or hyperinosis), exists in all true inflammatory diseases, especially those of a sthenic character, and those in young subjects, and in acute rheumatism. In some cases, MM. Andral and Gavarret found the proportion as high as twelve per thousand. So, likewise, whenever an inflammation supervenes in the course of another disease, there is always an augmentation in the quantity of fibrine. The proportion of fibrine is also increased during the latter months of pregnancy.[1] MM. Andral and Gavarret found an increase of fibrine also in tuberculous diseases, in which we have noticed there is a deficiency of red particles (§ 185). Mr. Gulliver has observed the increase of white globules in blood drawn in inflammation, and I have noticed this as occurring within the vessels. (See INFLAMMATION.) There are other diseases in which blood drawn exhibits a fibrinous or buffy coat, as in chlorosis, without there being any absolute increase of the fibrine; this will be noticed presently. It is observed in various states of atrophy and cachexia, whether from deficiency of blood or defective powers of digestion and assimilation, or excessive expenditure of the nutrient fluid.

196. *Deficiency of fibrine* (hypoplasma, or hypinosis) is of frequent occurrence in many diseases, and temporary conditions bordering on disease. Its sign is fluidity, or imperfect coagulation of the blood when drawn. As venous blood contains less fibrine and of a less perfect quality than arterial, so the quantity is absolutely diminished when the blood is more venous than usual, as in cases of asphyxia or impeded breathing; and in those of cyanosis, in which the venous blood becomes mixed with the arterial through an unnatural opening. Excessive bodily fatigue more or less expends the fibrine; hence the blood often remains fluid in animals hunted to death (§ 65). It was stated by John Hunter that the same thing is observed in animals killed by lightning, but this is not generally the case. In many instances, the blood is found fluid in cases of death from poisoning and other sudden causes. In some of these, the absence of fibrine may be attributed to the impeded respiration, which is the immediate cause of death, as in some cases of death from hydrocyanic acid, opium, strychnia, apoplexy, dividing the pneumogastrics (Dupuy), &c. There is, however, some uncertainty about these facts. (See Mr. Blake's experiments, mentioned farther on.) But in others, as in poisoning with arsenic, sulphuretted hydrogen, and some other pernicious agents, the fluid state of the blood must be ascribed to a more direct operation on the blood itself. So likewise in adynamic fevers, which arise from a peculiar poison, the fluidity or imperfect coagulation of the blood is one of the most remarkable conditions, and seems to be a chief cause of the

[1] In domestic animals, the fibrine is diminished before, and increased after, parturition. (Ann. de Chim. 1842.)

hemorrhages, petechiæ, and vibices, which sometimes occur in these fevers. In a case of very low typhoid fever, Andral found the proportion below one in one thousand. The artificial imitations of these fevers produced in dogs inoculated with various morbid or putrid matters, or confined over their exhalations, in the experiments of Gaspard, Magendie, Gendrin, Leuret, and Hamon, exhibited a similar absence of fibrine in the blood (§ 194). This absence of fibrine was observed by Scherer, in one case of putrid fever, to be accompanied by the presence of carbonate of ammonia, doubtless from incipient putrefaction.

The addition of some neutral and alkaline salts to the blood out of the body will diminish its coagulating property; and it has been stated that subsisting on salted food will produce a dissolved or hypoplastic state of the blood during life; but this statement does not appear to be founded on any well-ascertained facts, and is perhaps connected with the notions that salt food is the cause of sea scurvy (§ 63), and that the blood does not coagulate in this disease, both of which are erroneous. (See *Lib. of Pract. Med.*, Art. Scurvy, by Dr. G. Budd.)

197. Besides the sign already mentioned, permanent fluidity, or little coagulation of the blood when drawn, a defect of fibrine causes a tendency to hemorrhages, generally of the asthenic kind, and to an unmanageable oozing of blood from any accidental wound or breach of texture. In the same cases, too, wounds do not readily heal, nor fractures unite. In fact, the plastic or reparative process is defective for want of its material (§ 194); and for a similar reason, the nutrition of textures which consist chiefly of fibrine, such as muscle, is ill maintained.

198. Magendie found that animals, from whose blood fibrine had been abstracted, were affected with congestions and effusions in the lungs, brain, and other organs, which he ascribes to a cause supposed by M. Poisseuille to be a general physical fact; that very thin fluids pass with greater difficulty through capillary tubes than those of somewhat greater spissitude. But his experiments were too rude and his deductions too hasty to merit confidence; and the obstructions and congestions alluded to might be equally due to the cohesion of colorless or blood particles, or even to little clots of fibrine left by the coarse process employed. There can, however, be no doubt that a certain spissitude in the blood is favorable to its transit through the hydraulic apparatus of the circulation; and that when this is deficient, various irregularities in the distribution of the blood may occur. Some of these will be mentioned under the head of *anæmia;* but I may mention here that thin blood is easily thrown into sonorous vibration, and various unnatural sounds or murmurs in the heart, arteries, and veins, may be thus produced. As these are sometimes met with in cases in which the complexion does not indicate a deficiency of red particles, and they are sometimes absent in the most pallid subjects, I am inclined to connect them as much with defect of the fibrine and albumen as with that of the red particles of the blood.[1]

199. *Alterations in the quality of the fibrine* introduce to our notice

[1] This inference has been confirmed by the subsequent observations of MM. Becquerel and Rodier, who found that in the pallid cachexia from the poison of lead, in which the albumen is not diminished, the vascular murmurs are not present.

the important morbid appearances presented by the buffy coat and contraction of the clot of blood.

As the consolidation of the fibrine is the cause of the coagulation of the blood, so differences in the coagulum represent variations in the proportions and properties of the fibrine.

200. A large firm coagulum indicates an abundance of fibrine, as well as of red particles, and is commonly presented by healthy blood. A loose coagulum implies a deficiency of fibrine. A small firm clot betokens a proportion of fibrine exceeding that of the red particles; but the smallness of the clot points to another property of the fibrine, which is in excess, that of contraction during and after its consolidation. Again, in this case as in others, the upper part of the clot is commonly more contracted than the lower portion; it is also firmer, and contains more fibrine, whilst the lower abounds more in red particles. Here there is evidently a tendency to a separation of the red particles from the fibrine. In other cases, again, the separation is to some extent complete, the red particles subsiding, whilst the fibrine rises to the surface, and, on coagulating, forms at the top of the clot a layer of a light yellow or buff color, commonly known by the name of the *buffy coat.*

201. It may be inferred, then, that besides *coagulation* (§ 194), fibrine possesses a property of *contraction*, and another of *separation* from the red particles; and these properties are presented in different degrees in different states of the system. Let us consider these properties, first separately, afterwards in combination.

202. *Coagulation* is generally retarded in inflammatory diseases, and in other cases in which the fibrine is abundant (§ 195); its amount is indicated by the firmness and size of the clot. Other circumstances, however, may make the coagulation slow, as warmth and seclusion from the air; whereas cooling quickly, and exposure to the air, as when the blood trickles from the vein, or is drawn into a shallow vessel, hasten the coagulation. The addition of some saline matters, such as common salt, carbonate or sulphate of soda, also retards the coagulation of the blood.

203. The *contraction* of the clot evidently depends on the attraction of the particles of fibrine for one another after the coagulation has begun. By the contraction, the red particles entangled in the fibrine are also drawn together whilst a portion of the serum is squeezed out. The more slow the coagulation is, generally, the greater will be the contraction. Hence the upper surface of the clot is often formed more quickly (§ 202), and is therefore larger than that below, whilst the middle portions of this large upper film being drawn downwards by the contraction of that below, cause the *concave* or *cupped* appearance in the clot, so commonly seen in buffed blood (§ 200). By drawing blood slowly, or in a shallow vessel, the coagulum is speedily formed in all parts, and adhering to the sides it is not cupped (§ 202). The contraction and cupping of the clot being due to the fibrine, might be expected to be in proportion to its quantity; and this is the case in inflammatory diseases. But there is also great contraction and often cupping in chlorosis and some analogous states, in which the fibrine is not absolutely increased; the red particles being much diminished, the contractile property of the

fibrine is not impeded. For a similar reason the contraction is greatest where the quantity of fibrine is greatest, and most completely separated from the red particles. On the other hand, there is little or no contraction where the red particles are in proportionate abundance, as in sanguineous plethora (§ 184), or where the aggregation of the fibrine is impaired by the addition of saline matter (§ 196). In a boy under my care with purpura, Dr. Garrod found the fibrine in the blood quite as abundant as usual, amounting to 3 in 1000 parts, but it was remarkably defective in the usual contractile property; and the salts of the blood were in excess.

204. The *separation* of the fibrine from the red particles (§ 200), as exhibited in the buffy coat, has attracted much attention, and has been ascribed to various causes. As the fibrine always rises to the surface, and the red particles sink, it is obvious that a chief cause of the separation is the greater weight of the latter, which subside entirely from the upper layer of fibrine before it has time to coagulate. Now, this separation may be favored by four circumstances: 1, the tardy coagulation of the fibrine giving more time for the separation; 2, increased specific gravity of the red particles; 3, diminished specific gravity of the fibrine; 4, diminished spissitude of the liquor sanguinis. Now, two of these conditions may be fulfilled by adding a little salt to healthy blood as it flows from the vein; and this addition really does produce a separation of the fibrine; but the fibrine thus rising to the surface has neither the contraction (§ 203) nor the firmness of the inflammatory buff, but is gelatinous, like size, and rather resembles the sizy blood sometimes exhibited in scurvy and diabetes. Farther, although blood in inflammation is generally slow to coagulate, it is not so always; and in extreme cases, as in acute rheumatism, the buff appears even where the coagulation is speedy, and, according to Schroeder Van der Kolk, is seen in patches and thin films where gravitation would not have promoted the separation.[1] There must, then, be some other cause for the formation of the buffy coat besides those above mentioned. The great firmness and contraction of the surface of inflamed blood may be ascribed to the increased proportion of fibrine, which is constantly present.

[Whenever there is excess of fibrine, whether relative or absolute, and the coagulation of the fibrine does not occur too rapidly, it will accumulate alone on the surface of the clot, and form a buffy coat. Thus the blood of anæmia is buffed, whilst that of plethora is not; the buff in the blood of pregnant women is owing to the excess of fibrine relatively to the globules. This explains, too, the buff in the blood drawn from horses, where there is predominance of fibrine over the red corpuscles.—C.]

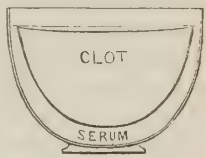
205. Dr. Alison considers the separation of the fibrine in inflammation to be due to a vital repulsion between the fibrine and the coloring matter. Dr. Hermann Nasse and Mr. Wharton Jones think that the tendency to separate may be entirely explained by the increased aggregation (before noticed, § 190), which they observed in the red particles of inflammatory blood (*Brit. and For. Med. Rev.* Oct. 1842, p. 592). This cohesion of the red corpuscles in separate piles, or rouleaux, would

[1] Alison's Outlines of Physiology, p. 89.

facilitate the separation, not only by contractile aggregation, but also by sinking through the liquid fibrine more quickly than separate particles would; just as bits of chalk fall to the bottom of water instead of remaining long suspended, as they would do in fine powder. Accordingly, Mr. Gulliver has observed that the red particles sink rapidly in proportion to this aggregation. But another circumstance favoring the separation of the buffy coat, is its own increased lightness, due apparently to an increased proportion of fat-globules contained chiefly in the pale corpuscles diffused through it.

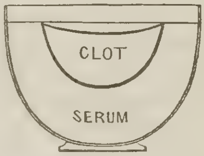
The subjoined sections of the different appearances of coagulated blood may assist the student to understand their nature and causes.

Fig. 1.



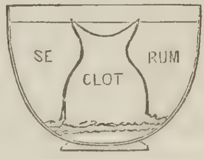
206. This presents uniform coagulation with little contraction. If the clot be moderately firm, the blood is rich in fibrine and in red particles, as in that from persons in robust health. If the clot be very soft and uniform, the fibrine is deficient, as in typhoid fevers, exhaustion from fatigue, &c. If the clot be very soft, especially at the bottom, and the top covered with a soft, sizy film, the coagulation has been slow, as in scurvy and in slight inflammations occurring in typhoid fevers.

Fig. 2.



207. This diagram exhibits uniform coagulation with great contraction, which takes place where the proportion of fibrine much predominates over that of the red particles, as in chlorosis. The relative as well as the absolute quantity of the fibrine is indicated by the firmness of the clot. This appearance, with a buffy surface, is often exhibited by blood drawn in inflammation in anæmic subjects or in advanced stages, and in phthisis.

Fig. 3.



208. Blood highly buffed and cupped, as in acute rheumatism and other severe inflammations. The fibrine here presents in a high degree its properties of separation, coagulation, and contraction; having abandoned the red particles, which are loose at the bottom of the vessel, and having risen to the surface, where it appears as a tough, contracted, concave, and buffy clot.

209. To exhibit the true properties of the blood in coagulation, it should be drawn by a full stream into a deep or globe-shaped basin or cup, previously warmed, and kept covered over until the coagulation is complete. These precautions retard the coagulation, and favor the separation and contraction of the fibrine. On the other hand, if the blood merely trickles from the vein, as when the orifice is small or the patient faint, or when the receiving vessel is shallow and cold, the blood congeals at once, and prevents the appearance of the buffy coat (202).

This is one reason why blood drawn at one bloodletting often exhibits a different appearance in different vessels.[1]

210. We have before noticed that the fibrine of the blood may be speedily exhausted by violent muscular exertion, and by serious impediment to the respiration (§ 196). These, and the fact that it exists in larger proportion in arterial than in venous blood, seem to point out that it is expended in the nourishment of the muscular and other textures, and is renewed through the agency of respiration. It might be supposed that inflammation increases its quantity by accelerating the circulation and respiration without adequate expenditure; but although this may be a contributing cause, particularly in acute rheumatism, it is not sufficient, for the quantity of fibrine is not proportioned to the frequency of the pulse or respiration; it is often much increased before these are materially affected, and in idiopathic fevers it is diminished, although the breathing and pulse are commonly accelerated. In fact, various circumstances, to be detailed hereafter, render it probable that the increase of fibrine during inflammation has its origin in the vessels of the inflamed part.

211. It has been before stated (§ 194), that the coagulation of fibrine in the blood is favored by two circumstances, the presence of the pale corpuscles, or of their constituent granules, and the formation of the deutoxide of proteine by some oxygenating process operating on the albumen; the same circumstances appear to be mainly instrumental in its formation. Thus, as Dr. Carpenter has pointed out, the fibrine appears in the chyle of the lacteals after their passage through the mesenteric glands; it increases in the thoracic duct, and becomes still more abundant in the blood in the lungs where there is a free supply of oxygen. It is quite uncertain how much in this process is due to vital influence, but there is good ground for belief that much of the change is of a chemical nature. The *molecular base* of the chyle (Gulliver) supplies a congeries of minute fat-globules which have a tendency to attract around them thin films of coagulated albumen (Ascherson), probably identical with *fibrine* or *deutoxide of proteine;* and this process takes place in proportion as oxygen is supplied from the adjoining red blood-disks; thus the molecular base is converted into single and aggregated *granules* or *pale corpuscles* of the chyle and blood. The oxygenating process extends farther, and converts a small portion of albumen into an oxyproteine, still liquid, but ready to take the form of a finely fibrillated solid (fibrine), under various circumstances before adverted to (§ 194); and the perfection of this material, and its susceptibility of the process of farther organization, form additional characters of fibrine, which appears to belong to the class of vital rather than mere physical properties. These will be noticed in the next paragraph; but we may observe here that they will much depend on the quality of the chemical materials, oil and proteine, which the chyle and blood contain, and the activity of the processes of circulation and respiration, which are continually acting on these fluids.

[1] For much interesting information on the coagulation of the blood, the reader is referred to the edition of Hewson's works, published by the Sydenham Society in 1846, with the valuable notes of Mr. Gulliver.

212. Fibrine, or the buffy coat of the blood, is the material of which new membranes and cicatrices are formed, constituting the *coagulable lymph*, which is the plasma or basis of the constructive or reparative process. In its capacity for this process, fibrine exhibits some varieties. The plasma with which old textures are nourished, and new ones formed, is *euplastic* in a healthy state, having a capacity of life, and may become organized in a high degree, as in the case of false membranes resulting from acute inflammation in a healthy subject. But in many instances, this capacity is degraded, and the nutritive material is *caco-plastic*, susceptible of only a low degree of organization, as in the indurations resulting from low or chronic inflammation, in fibro-cartilage, cirrhosis, gray tubercle, &c.; or it is *aplastic*, not organizable at all, as in pus, curdy matter, yellow tubercle, &c. It is a fact of great importance, that the quantity of fibrine in the blood, and the facility with which it may be effused, are by no means in proportion to its plasticity, or capacity to become organized; thus it is abundant in the blood, and freely effused in the inflammations of scrofulous or tuberculous subjects, although in such the products of these inflammations and of nutrition are commonly caco-plastic or aplastic. The fibrine of the blood or coagulable lymph in these cases, is more opaque and less elastic than in healthy subjects, and under the microscope, presents a predominance of granular matter and fat-globules, and less of the finely defined fibres and regular nuclei, as if it were imperfectly elaborated, and resembled coagulated albumen rather than the more animalized form of proteine. Even the more perfect forms of fibrine, if in a position in which their vitality is not sustained by becoming organized, tend to degenerate and become disintegrated into an opaque aplastic matter (Gulliver), and this eventually may undergo a farther chemical change into fatty and calcareous matter, like other aplastic deposits. It is interesting to observe that in these cases, also, the red particles are defective in number (§ 185); and this suggests a probable cause of the imperfection of the plasma.

213. The coagulation of fibrine is promoted by the contact and motion of a rough solid; thus by stirring fresh-drawn blood with a stick, the fibrine adheres in shreds to the stick. The same property is exhibited within the body in the deposition of lymph (vegetations) on rough surfaces within the heart and great vessels, and it is probable that the fibrinous concretions called polypi, which are found after death in the heart, are formed on its irregular surfaces, as its failing motions cause agitation more than propulsion of the blood. The cohesive property of fibrine especially characterizes it, and causes it to aggregate in patches and films on the surface of membranes; and where it is most plastic, it may be drawn into threads or bands.

Remedial Agents.

214. *Hyperinosis*, or *excess* of fibrine (§ 195), is less reduced by blood-letting and low diet, than is excess of the red particles; yet these are the chief means of effecting this object. It would probably be found that purgatives, and other remedies which increase much the more solid secretions, diminish the fibrine. A similar property has been ascribed to mer-

cury, to alkaline salts, to iodine, and to antimony; there is a want of experimental proof in support of this notion; yet it is favored by some analogies, and seems well worthy of fuller investigation.[1] The operation of salts and alkalies in this way was probably suggested by their property of dissolving fibrine out of the body.[2]

215. According to the views of Dumas and Liebig, subsisting chiefly on saccharine, amylaceous, or gelatinous articles of food, must reduce the fibrine and albumen of the blood; and such food is found by experience to be the best in inflammatory diseases, in which excess of fibrine is a chief element. Is the reputed efficacy of the "cure de raisins," in tuberculous disease, connected with the absence of proteine compounds in the food? Bodily exercise reduces the fibrine, and may be advantageously employed with this view in sthenic plethora and in scrofulous hyperinosis; but is not admissible in inflammatory diseases. Neither can we suggest any practicable mode of lessening the fibrine by lowering the function of respiration, on which its supply seems to depend, unless narcotics, which impair many organic functions, have some action of this kind. The known utility of opium, aconite, &c., in rheumatism and low forms of inflammation, in which excess of fibrine is a constant element, makes this matter deserving of some research. Simon mentions one case of phthisis long treated with cod-liver oil, in which the fibrine in the blood was reduced in a remarkable degree.[3]

216. *Hypoplasma*, *hyponosis*, or *deficiency of fibrine* (§ 196), is to be remedied by assisting those functions on which its supply depends, particularly those of digestion, circulation, respiration, and assimilation, and by avoiding its expenditure by too much exercise, and other exhausting processes. If the digestive organs will bear them, meat, eggs, bread, and other articles of diet abounding in the proteine compounds, should be taken. The digestive and assimilative functions may be assisted by stimulants, bitters, quinia, and the mineral acids, which, from their

[1] Dr. Karl Popp, in his elaborate researches on the composition of the blood, infers that tartar emetic and nitre, and in a less degree calomel, diminish the amount of fibrine.—Dr. Day, in *Ranking's Abstract*, June, 1846.

[2] Mr. James Blake* has made many experiments by injecting various saline and other fluids into the veins, and he has furnished me with a summary of their effects on the blood, as found after death.

The blood was found coagulated after the injection of the following matters: Liquor potassæ (firmly); carbonate of potass (firmly); nitrate of potass (firmly; blood scarlet); nitrate of soda; nitrate of ammonia; nitrate of lime; nitrate of baryta; chloride of calcium; chloride of barium; chloride of strontium; sulphate of magnesia; sulphate of copper; acetate of lead; arsenite of potass; nitric acid (strongly); narcotine (firmly); tobacco; strychnia (moderately); conium; hydrocyanic acid; euphorbium; and water in quantity.

The blood was not coagulated, or imperfectly so, after injection of caustic soda, carbonate of soda, sulphate of soda, ammonia, nitrate of silver, sulphate of zinc, sulphate of iron, phosphoric acid, arsenic acid, arsenious acid, oxalic acid, infusion of galls, of digitalis, alloxan.

Some of these results are different from what might have been expected; instance the decided coagulation with potass and its salts, especially nitre, and the fluidity with nitrate of silver, sulphate of zinc, infusion of nutgalls, which have been commonly supposed to possess a coagulating property.

[3] [Animal Chemistry, by Day, p. 230, Am. Ed.]

* [The present Professor of Anatomy in the St. Louis University, Missouri.]

power in stopping passive hemorrhage, in augmenting the muscular substance and strength, and in causing the healing of phagedenic and flabby ulcers, seem to promote the formation of fibrine more directly than by their mere operation on the digestive organs. To improve the function of respiration, besides attempts to remove or diminish any disease from which it may suffer, the free access of pure cool air to the lungs should be secured. The injurious effect of exertion is exemplified in the relapses which it often induces in continued fever, in which, defect of fibrine in the blood is a chief element. Fatigue of every kind, and wakefulness, should be carefully avoided, and sleep obtained by narcotics, if it do not come naturally. In case of deficiency of fibrine from the presence of a febriferous or putrescent poison in the system, it is not to be expected that fibrinous food, rest, or any other means, can remove the deficiency, so long as the poison remains in active operation. This poison, by its septic or analogous influence, interferes with the vital process by which the fibrine is formed. But no sooner does the influence of the poison subside, as evidenced by improvement in the symptoms, than the quantity of fibrine increases; and this sooner than could be explained by any increase of nourishment taken (Andral and Gavarret).

217. Very little is known of the power of remedies to correct changes in the *quality* of the fibrine of the blood. The increased properties of separation (§ 204) and contraction (§ 203) manifested by blood in inflammation, are reduced by bloodletting and other antiphlogistic remedies, even more constantly than the excessive proportion of fibrine is by the same means; but they seem to be soon reproduced if the inflammation continues. Thus, although the last cup drawn in bloodletting may exhibit none of the buffed and cupped appearance presented by the first cups, yet blood drawn a few hours after, often shows as much as any taken before. Knowing that this speedy recurrence of morbid properties in the blood depends on the influence of the local inflammation, we see the necessity of fully using local means, together with those calculated to operate on the system.

The beneficial influence of saline medicines in inflammatory diseases, is supposed by Mr. Gulliver to depend on their power to prevent the cohesion of the blood-particles, and he suggests the free application of salt lotions to an inflamed part. The application of salt to a recent wound, is a well-known popular remedy.

218. Bloodletting and other general antiphlogistic remedies, if they do not remove local inflammation, may render its products more injurious by lowering their plasticity (§ 211), and approximating them to tuberculous and other aplastic deposits. Thus, chronic inflammation continuing after the full application of the antiphlogistic treatment, almost surely tends to produce degenerated changes of structure, over which remedial art has little power. In connection with this subject, therefore, we see how desirable it is that inflammations should be removed before they become chronic; and when there is a risk of their becoming so, it should be an indication to improve the condition of the blood by a tonic and nutritive plan, at the same time that local antiphlogistic measures may be necessary for the lingering inflammation.

219. A similar tonic treatment is still more indicated in scrofulous, chlorotic, and other cachectic states, in which the fibrine, although less abundant than in inflammation, is yet copious in proportion to the scanty red particles (§ 212). Hence the tendency to the deposit of imperfect fibrine and granular matter (§ 211), even independently of inflammation; and besides means calculated to improve the nutrient functions, and to raise the character of their product, it may be necessary to use remedies likely to keep the fibrine dissolved, and to prevent its deposit in its aplastic forms. Alkalies and iodide of potassium have been supposed to have some claims to these properties; but more efficacy seems to attach to regiminal and dietetic means, which, excluding all food containing solid fat, and proteine matters of the lower class (such as caseine), secure the freshest and most nutrient food, and promote the digestion, respiration, capillary circulation and excretion, by healthy air, exercise, frictions, and suitable medicines.

SECTION IX.

ALBUMEN AND OTHER ANIMAL PRINCIPLES DISSOLVED IN THE SERUM.

220. These form a considerable constituent of the blood, amounting on an average to between seventy-six and eighty per thousand in health. It is generally supposed that the albumen of the serum is chiefly useful as affording the material from which the plasma (fibrine) is elaborated; but it is by no means certain that some textures, such as those less highly organized, composed of albumen and gelatine, may not be formed at once from the constituents of the serum. The albumen is farther useful in giving to the serum a consistency favorable for its circulation, for suspending and preserving the red corpuscles, and in blandly sheathing the acrimony of the saline constituents. The quantity of albumen is estimated by Andral and Gavarret at from 7 to 8 per cent. It may be generally inferred from the specific gravity of the serum, which in healthy subjects averages at about 1030.

221. *Excess of Albumen* exists in most cases of inflammations and fevers, especially during their more active stages. Its increase is not, however, in proportion to that of the fibrine. Its relative proportion is much increased in epidemic cholera; but this is rather due to the removal of the water of the blood. Albumen is the principle least affected in its proportions by disease. Very poor living, long-continued extensive hemorrhages, and other drains on the system, will pretty surely reduce it in common with the other animal principles of the blood; but good living has less power in raising it above the natural standard. In the pallid cachæmia of persons long suffering under paraplegia, it has been ascertained by MM. Becquerel and Rodier, that the albumen is not diminished, and is therefore, in excess, as compared with the other solid constituents of the blood.

222. *Deficiency of Albumen* in the blood is most remarkably met with in cases of albuminuria, or disease of the kidney with coagulable urine; and this deficiency precedes the diminution of the red particles, which takes place in the advanced stages of this disease. Dr. Bright found, in a patient with albuminuria, the specific gravity of the serum as low as 1013. (*Bright's Reports*, vol. i. p. 85.) Dr. Babington found the specific gravity of the serum in a case of diabetes as low as 1024; in another 1027, although that of the blood was higher than usual, 1061. In this case the serum was milky. (*Cycl. of Anat.* &c. Art. "Blood.") In their latter researches, MM. Andral, Gavarret, and Delafond, discovered a remarkable diminution of the albumen in dropsical sheep affected with the rot (a watery state of the blood, with distomata in the liver). Sheep in a cachectic state, with deficiency of red particles, but without entozoa, were not dropsical, and in these, the albumen was found undiminished. It is therefore most probable that the cases of cachexia, or anæmia, attended by dropsy, owe this concomitant to a defect of albumen in the blood. It is this principle chiefly that gives the blood liquor its spissitude, which renders it more fit to pass along the vessels, and prevents it from transuding through their walls. This deficiency of albumen, therefore, seems to be a chief constituent of the dropsical diathesis.

We are not acquainted with any means of increasing albumen in the blood where it is deficient, farther than those which restrain wasting discharges, and improve general nutrition. A case is mentioned by Simon (*Animal Chemistry*, by Day [p. 230, Am. Ed.]), illustrative of the extraordinary nutritive properties of cod-liver oil in phthisis; the solid constituents amounted to 25 per cent., the albumen being above 13; whilst the fibrine, which is usually high in phthisis, was reduced below the normal proportion.

SECTION X.

OIL.

223. The oil or fatty matter in the blood sometimes is so much increased as to give a milky appearance to the serum; and this increase may arise under different circumstances, and from various causes. The most common is that originally suggested by Haller, and lately proved by Dr. Buchanan, that it depends on the presence of unassimilated chyle (§ 211). The latter physician has ascertained that the serum is generally milky in blood drawn four or five hours after a full meal. In other instances, this appearance has been observed during illness after long fasting, and doubtless proceeds from the absorption of fat from the textures, as supposed by Hewson. In some cases, a turbidity in the serum has been found to depend on an increased number of minute granules of albumen or fibrine, soluble in acetic acid, and not affected by ether. (Vogel's *Path. Anat.* by Dr. Day [p. 48, Am. Ed.]. Notes to *Hewson's Works*, by Gulliver, p. 85.) Dr. Babington met with an extreme degree

of milky serum in a case of advanced diabetes. This physician states that he has repeatedly found milky sérum to have a low specific gravity, indicating a deficiency of albumen; and he suggests that the fat might originate in a change in the albumen. A similar idea has frequently occurred to me, when considering the remarkable instances of fatty transformation exhibited in degenerating textures and deposits, and even in slowly decaying animal matter, as in the instance of the production of adipocire. I shall revert to this subject under the head of *Transformations and Degenerations.* The fat of the blood seems to vary in its nature; cholesterine and margarine are often found in old and cachectic persons, and often abound in the degenerated tissues and cacoplastic deposits of such subjects.

224. The increase of fat in the textures is probably preceded and accompanied by its presence in excess in the blood; and the circumstances which promote obesity must operate through the composition of this fluid. Of these may be mentioned fat, sweet and farinaceous food in excess, yet without causing disorder of the digestive organs; full living with sedentary habits, and especially combined with the free use of malt liquors; imperfect assimilation, often connected with imperfect exercise of the respiratory organs, from disease or disuse; insufficient excretion of bile. Exercise tends especially to reduce the fat of the body, probably by causing its combustion in respiration, whilst the nutrition of muscular textures is increased by the same influence. Thus, unhealthy fat commonly increases at the expense of strength, and is reduced in proportion as muscular power is restored. In addition to the use of as much exercise as the strength will bear, and the invigorating influence of pure air, and the avoidance of all fat and other articles of food abounding in hydrocarbon, some advantage may be derived from the employment of food and medicines in which oxygen and azote predominate, such as nitric acid, benzoate of ammonia, and some vegetable acids.

Defect of fat in the blood has not, to my knowledge, been observed; but it may be presumed to occur in cases of inanition and emaciation of long standing, particularly in those of advanced stages of malignant disease and tabes mesenterica. This element of disease, and the still more important one of *alteration* in condition of the fat-globules which form the basis of nutrition, will be better considered under the head of diseased nutrition, when the remarkable powers of the cod-liver oil as a remedy, will demand our attention.

SECTION XI.

SALINE MATTER.

225. The saline matter dissolved in the blood tends to preserve the form of the red particles, and the fluidity of the fibrine. Vogel states that it is in excess in scurvy, and causes the hemorrhagic disposition in that disease; but this does not accord with what has been observed in

this country (§ 196). He also thinks that the same cause renders the red corpuscles granular or puckered at their margin by withdrawing some of their fluid contents. Such an appearance of the red particles, as well as an excess of saline matter, exists in the blood of a boy with purpura, now under my care.

There can be little doubt that the thirst induced by salt food is connected with an excess of saline matter in the blood, which causes a shrinking in size of the red corpuscles; and wherever they circulate, they attract by endosmose fluid from the textures and surfaces, exciting that demand for liquid which the feeling of thirst is intended to supply.

226. *Diminution* of saline matter in the blood has been said, by Dr. Stevens, to take place in yellow fever and other pestilential diseases, and to cause so dark and grumous a state of the blood, that exposure to air will not, as usual, render it florid. This fact has been more distinctly ascertained by Dr. O'Shaughnessy, with regard to malignant cholera, in which the defect of saline matter and water seems to be the immediate cause of the obstructed circulation, lividity, and collapse, so remarkable in that terrible disease. Accordingly, Dr. Mackintosh found the blood extensively coagulated in the heart and large vessels. There can be no doubt, therefore, that in the extreme cases just mentioned, the blood coagulates in the vessels for want of saline matter, and the red particles become dissolved and altered.

227. Hence the temporary efficacy of injection of saline solutions into the veins of cholera patients; it seems at once to renew circulation, respiration, warmth, and other functions—life, in fact, to the patient—as if the saline solution were all the thing needed. But this defect of serum in the blood is only an effect of the excessive evacuations from the stomach and bowels; and if these go on, the good effect of saline injections is soon exhausted.

The researches of Andral scarcely support the notion that similar changes take place in typhus fever, as supposed by Dr. Stevens. If saline medicines are useful in common continued fevers, it is a question whether it is in this way, by supplying what is defective; it may rather be by augmenting deficient secretions (§ 171), and tending to remove or counteract septic influences present in the system (§§ 98, 105).

It is stated by Henle that a diminution of saline matter takes place within inflamed bloodvessels; but this statement seems to be no more than an assumption to aid his favorite explanation of the obstruction in inflammation.

SECTION XII.

WATER.

228. The average proportion of water in healthy blood may be stated at about 80 per cent. It is obvious, from what has been already noticed, that this proportion increases as that of the animal contents decreases.

Thus, after extensive hemorrhages, and in chlorosis and other cachectic states attended with anæmia, the blood is more watery than usual. The effect of this state of the blood is to cause a tendency to dropsical effusions and fluxes, besides the consequences which result from a deficiency of the other constituents of the blood.

229. I have before suggested a question (§ 187), whether the serious functional disturbance sometimes following the ingestion of very large quantities of liquids, particularly after exertion, when absorption is active, may not in some degree arise from the too copious and sudden addition of water to the blood. Certainly temporary plethora, with palpitation, feeling of oppression or dyspnœa, often results from the too free ingurgitation of liquids, and is not removed until perspiration, or a free flow of urine, relieves the distended vessels. These symptoms are most distinctly observed where some permanent disease of the organs of circulation or respiration incapacitates them for the increased task. Hence the aggravation of the symptoms of disease of the heart and lungs, by too much drink. The colliquative sweats in phthisis seem to arise from a similar cause, and may often be relieved by a judicious reduction in the quantity of liquid food.

230. *Deficiency of water* in the blood is exemplified in epidemic cholera, in which the specific gravity of the serum has been found as high as 1045 (Lecanu), which implies a reduction of nearly half the natural proportion of water. Some diminution probably takes place in other diseases attended by profuse watery discharges, such as diarrhœa, diabetes, and excessive sweating. In these cases, the smallness of the pulse, and sometimes the shrunk appearance of the surface from the undistended state of the vessels, are signs of the diminished bulk of the circulating fluid; and thirst pretty constantly points out the mode which nature prompts to remedy the defect. In the same way, exposure to heat, especially if continued, and prolonged violent exercise, expend the water of the blood, and cause the feeling of thirst through which it may be restored. Long abstinence from liquids has a similar effect.

It has been already mentioned, that the extraordinary decrease of the water of the blood which occurs in malignant cholera, renders the blood so thick that it cannot circulate freely, and this change is the chief cause of the cessation of the pulse, lividity, and other signs of obstructed circulation. No such effect is known to follow from any of the other causes of deficient water. The operation of heat and continued exertion is not simple, and therefore not referable to this principle only. Abstinence from liquids for two or three days induces languor, small and easily accelerated pulse, a somewhat pasty state of the mouth, and scantiness and turbidity of the urine, but little derangement of other functions. The digestive process, which might be expected to suffer, in some cases at least, shows no symptoms of disorder.

231. We thus have means of increasing or reducing the water of the blood by increasing or diminishing the liquids drank; and these expedients may be usefully employed in the cases above mentioned. But these expedients in their extremes also furnish us with therapeutic agents of more extensive power. Drinking large quantities of water may, in a

salutary manner, excite the whole vascular system and its connected secreting organs, and may thus wash out of the blood various effete or noxious matters; and this is a chief good which the "water-cure" sometimes effects. The free use of liquids is supposed, by Prout, to prevent the formation of lithic acid, or, according to Liebig, it facilitates its conversion into urea. On the other hand, a total abstinence from liquids for two or three days, is an effectual mode of stopping fluxes, and of relieving catarrhal inflammations and congestions. Either plan exerts an alterative operation on the circulation and secretions, which, if more studied, may perhaps be turned to good account in the treatment of many diseases.

SECTION XIII.

CHANGES IN THE BLOOD BY RESPIRATION.

232. The process by which venous blood is made arterial, and rendered fit for its purpose of maintaining the life and functions of the several parts of the body, is liable to variations; and the resulting differences in the state of the blood form an important element of disease.

The conversion of venous into arterial blood comprises the absorption of oxygen, the removal of some carbonic acid and water, a slight increase of fibrine, and possibly other changes. Each of these elements of the process is probably concerned in giving to arterial blood its fitness for its function; the absorbed oxygen, by its affinity for the hydrogen and carbon of the blood and textures, aiding in those processes by which these are renovated in function as well as in structure, superfluous fat, and other combustible matters consumed, and heat is evolved; the renewal of fibrine supplying the expenditure of the plasma, particularly in the muscles; and the removal of the carbonic acid being the excretion of a noxious matter.

233. It is doubtful whether this change is ever carried on in *excess;* for, by an admirable adaptation, the activity of respiration is proportioned to the rapidity of the circulation and the corresponding need of change in the blood. Thus exercise, which accelerates the circulation and changes of the blood, also augments the breathing movements. In fevers, also, the frequency of the pulse and of respiration is increased; but the muscular strength being much impaired, it is doubtful whether the rapidity of the circulation or the real amount of the respiratory changes is generally augmented in proportion. It has been said that, in acute rheumatism, the circulation and respiration are too active for the wants of the system, and that the blood reaches the veins without having wholly lost its arterial character. If this were true, it might in some measure explain the great increase of fibrine in the blood in this disease; but the fact is not well established.[1]

[1] It seems to me that Professor Liebig has given too mechanical a view of the change of the blood in respiration. He appears to consider the increased arterialization of blood,

234. *Defect* of the change in the blood by respiration is a common and important element of disease, and constitutes a chief feature of affections of the respiratory apparatus. Being the essence of the special disease *asphyxia*, or *apnœa*, its minute consideration belongs to special pathology, and we shall here only describe it in its more general characters.

The amount of mischief arising from defective respiration, varies greatly according to the sudden or the gradual supervention of the defect. An acute attack of the organs of respiration may prove distressing, and even fatal, by an impediment to the breathing, much smaller than that caused by chronic diseases, the gradual infringement of which may be scarcely perceived. Thus, too, persons affected with extensive emphysema of the lungs, are habituated to an imperfect state of respiration, which is shown by a constant lividity of the lips and cheek ; such an appearance would be a sign of approaching death in other persons. The cause of this difference is not merely the general fact that sudden changes produce more effect than slow changes, but it lies chiefly in the fact that the importance of the respiratory function varies under different circumstances. When the several parts of the body, especially the muscular, are in a state of full activity, more breath is needed to remove from the blood the noxious effete matter which always results from functional exercises. Hence in such a condition (which is that of healthy action), the respiratory process cannot be abridged without serious disorder. This disorder is first obvious in the increasing feelings of oppression and suffocation which the want of breath causes, and which excite forced exertions to breathe. If these exertions still fail to duly aerate the blood, it is partly arrested in the lungs, right compartments of the heart and veins, and part passes in an imperfectly arterial state to the left side of the heart and arteries.

235. The phenomena of asphyxia are thus compounded of : 1, accumulation of blood in the venous system ; 2, diminution of blood in the arterial system ; and 3, deficiency of oxygen and excess of carbonic acid in the blood. These several conditions cause injury to the vital functions, both by the want of a due supply of blood, and by the bad quality of that blood, which is injurious—negatively, for want of oxygen, the proper exciting agent, and positively, from its excess of carbonic acid and other excrementitious matters, which are sedative. The symptoms induced are also of two classes : 1. Those implying failure of function;

during exercise, and on exposure to cold, to be a necessary consequence of the greater amount of air inhaled, in one case by accelerated movements of the chest, in the other, by the greater density of the cold air. But if the extent of the changes wrought by respiration were in exact proportion to the quantity of oxygen received into the lungs, how easy would it be to increase them (and thereby animal heat also) by voluntarily augmenting the respiratory movements. I cannot but think that the proportion of oxygen absorbed, and of carbonic acid expired, depends more on the condition of the blood brought to the lungs, and that the respiratory movements are regulated by this. Thus the increased oxygenation of the blood is a consequence of greater changes previously wrought in the blood itself, and not a mere result of a fuller access of air. In confirmation of this view, I may mention an experiment which any one can repeat ; if a succession of moderately deep and quick respirations be performed during several minutes, at a pretty low temperature, the effect is to cause feelings of chilliness and faintness, rather than of increased warmth and energy ; it is like extinguishing a fire by overblowing it.

such as muscular debility, feeble action of the heart, pallor and coldness of the surface and extremities, and abolition of the senses and mental faculties; and, 2. Those arising from congestion and the noxious influence of the black blood; such as palpitation, flashes in the eyes, noises in the ears, delirium, muscular spasms, &c. Each of these set of symptoms may predominate in different cases, and this causes a variety in the phenomena of asphyxia, which has not been sufficiently noticed by writers on this subject.

236. But we have to notice the other mode in which the changes by respiration may become defective, that occurring gradually, or when the functions are not active. It is well known that hybernating animals breathe scarcely at all, and yet they live; and this is obviously because their functions are reduced to an extremely torpid state. So, too, animals newly-born will bear the privation of air for a much longer period than those which are older; and it has been supposed that, in adults, failure of the heart's action by syncope retards the operation of asphyxiating causes.—(Dr. Carpenter on Asphyxia, *Library of Med.* vol. ii.)

237. Although a man cannot be reduced to the torpidity of hybernation, yet it is certain that he may be brought to bear a defect in the respiratory changes, which would be fatal in a few minutes under common circumstances. This is seen when the defect is congenital, as in those affected with malformations of the heart causing cyanosis; and it is also seen where the defect is very gradually induced, as in the case of emphysema of the lungs.

238. In cases of cyanosis (the blue disease, in which, from malformation of the heart some venous blood passes into the arteries), we have the opportunity of observing the more essential effects of defective arterialization of the blood. Individuals thus affected, are in a lower scale of animation. The slower processes of nutrition and secretion seem to go on pretty well, but the muscular power is low; slight exertions bring on symptoms of faintness, palpitation, suffocation, or insensibility; the animal heat is lower than natural, and there is greater suffering from the influence of cold. In short, all the powers of body and mind are slender, and are easily disordered by any circumstances which tax their activity. In the few that reach mature age, there is no sexual passion, which seems to be a happy provision against the chance of perpetuating a race of malformed beings—human reptiles. The subjects of cyanosis are said to be very liable to hemorrhages, and when these occur spontaneously, or from accidental causes, it is very difficult to stop them. This must be ascribed to the deficiency of fibrine, which we have already found to occur where the changes of the blood by respiration are imperfect (§ 196). The same peculiarity occurs in the fœtus.

[The author here adopts the old, and now almost exploded, pathology of congenital cyanosis. It has been satisfactorily shown by Drs. Johnson, of London, West, Moreton Stillé, and Dunglison, of Philadelphia, Craigie, of Edinburgh, Louis and Valleix, of Paris, and particularly Norman Cheevers, of London, with many others, that this affection is not due to the direct admixture of venous with arterial blood—at least, in a large majority of cases. Louis was the first, we believe, to show that

an opening might exist between the right and left sides of the heart, without the production of the cyanotic hue; and, that this condition might be present without any malformation of that organ. His observations, made prior to 1826, have been since abundantly confirmed by the authorities above quoted. The same distinguished observer then expressed the opinion that, in many cases, the disease in question was caused by congestion, due to some impediment in the venous circulation. Dr. Moreton Stillé, in an able inaugural essay on Cyanosis, attempts to show, by the analysis of a number of cases, that the pulmonary artery was uniformly either imperforated, contracted, or obstructed, or that some physical obstacle to the natural course of the blood of analogous action existed, and "that the essential characteristics of cyanosis are constituted by general venous congestions," and "that it depends simply upon any cause which, acting at the centre of the circulation, will produce a stasis of venous blood in the capillary system."[1] The extensive researches of Dr. Norman Cheevers[2] confirm the views held by Dr. Stillé.—C.]

239. In connection with the scantiness of fibrine in the blood, when the respiratory changes are defective, we must notice the weakness of the muscles generally, which are probably nourished by the fibrine. This weakness is often observed in the subjects of extensive disease of the lungs, especially emphysema. In these same subjects, the deposition of fat is, on the other hand, often excessive, which agrees very well with Liebig's idea that respiration directly consumes the oily parts of the blood; the respiration being defective, the fat accumulates (§ 224).

240. *Remedial Measures.*—Besides the obvious indication of endeavoring to restore the respiratory function where it is defective, the view which we have taken of the mode in which the defect is hurtful (§ 234), suggests means by which its injurious effect may be diminished. Thus circumstances which lower the activity of the functions, often give relief. Of these, complete rest to body and mind, warmth to the surface and extremities, whilst air is supplied cool and fresh to the face and air-passages; and various sedatives, which reduce the circulation and other functions to a lower standard (or, in the language of Laennec, diminish the want of breath), such as digitalis, conium, hyoscyamus, &c., are the chief. Other medicines, such as ether, belladona, stramonium, lobelia, &c., which sometimes relieve dyspnœa, probably act in another way, by relieving spasm or other impediments to the respiration.

241. In extreme cases bordering on asphyxia, the enfeebled circulation may require stimulants (§ 235), and the engorgement of the venous system may indicate depletion; in different instances, each of these conditions may most need attention, and sometimes both must be treated in the same case. It appears from the researches of Chossat, Erichsen, and others, that no stimulant is so generally useful as that of heat to the whole body; and in the experience of the officers of the Royal Humane Society, the warm-bath has been found the most useful remedy

[1] Am. Journ. Med. Sciences, N. S. vol. viii. p. 25, 1844.
[2] Lond. Medical Gazette, March, 1847.

in restoring animation suspended by submersion. Warm frictions, and stimulating applications, are likewise very serviceable in exciting the failing circulation.

242. Experience has not yet furnished us with the means of arterializing the blood by any other process than that of respiration. This process may, in some cases, be aided artificially, either by mechanical means, as inflation of the lungs, electricity applied to the muscles of respiration, the diaphragm, and abdominal muscles alternately; and by bronchotomy;—or by chemical means, the supply of oxygen or nitrous oxide for respiration. Whether the internal administration or the injection into the veins of saline and other matters, containing much oxygen in loose combination, such as the chlorates, nitrates, and some peroxides, may be made in any degree to supply the defect of respiration, is uncertain, but it deserves more extensive trials than it has received. If these matters could furnish oxygen to the blood, they would yet leave undone the other office of respiration, the removal of carbonic acid. Might this be accomplished by the administration of free alkalies? In some cases of asphyxia by carbonic acid gas, I have thought that some benefit in the progress towards recovery, was derived from the use of liquor potassæ, with chlorate of potash. Perhaps warm baths containing these ingredients might be of some use. Friction of the surface of the body, with solutions of these and similar matters, might also prove serviceable.

243. The congested state of most organs which occurs when the respiratory process is imperfect, renders necessary remedies suited to remove this state; and it is from a disregard of this consequence of imperfect breathing, that many fall victims to the secondary effects of apnœa. The lungs, the brain, and the liver suffer most. The best remedies in these cases are mercurial and other medicines, which act freely on the secretions (§ 173). Probably, these remedies act, in part by making the liver assist the lungs in the office of decarbonizing the blood. The speedy relief afforded to dyspnœa by a bilious diarrhœa, has several times seemed to me to countenance this notion.

244. When, from disease, the respiratory changes are reduced to a narrower sphere, it becomes an object not to increase the hydrocarbon of the blood by the use of food with much fat, or containing spirit, but to make lean meat, and other fibrinous articles, with farinacea, and fruit abounding in vegetable acids, the chief sustenance.

245. There is little to be said on the subject of *excess of changes in the blood by respiration*, as it is not certain that such a condition ever exists as an element of disease. It has been supposed, that, in most sthenic febrile diseases in which the function of respiration is not impaired, this function must be more active in proportion to the accelerated circulation. Acute rheumatism gives an example of this kind, and Dr. Christison states that the blood drawn from a vein is much more florid than usual. If this be a correct observation, this hyper-arterialization of the blood may, perhaps, account for the unusual quantity of fibrine which it presents in this disease. I must, however, remark that I have found the excess of fibrine in cases in which there had been no remarkable acceleration of the pulse or respiration. We shall see, hereafter,

that the increase of fibrine is connected rather with the local inflammation than with the fever.

246. From the experiments of the late Mr. Brougton, it appears that when animals are confined in oxygen gas, they, in the course of a few hours, die comatose; the respiration first ceases, whilst the heart continues to beat with vigor, and the blood, even in the veins, is quite florid; it also presents the arterial character of very speedy coagulation. It appears, then, that excess of oxygen injures first the nervous function (§ 154); but whether it does so by exhausting it by previous excitement, or by the coagulability of the blood, or by the excessive production of carbonic acid, is not decided by any known experiment. The last-named mode is the most consistent with the related phenomena; it can scarcely be doubted that an increase of oxygen in the blood must augment the production of carbonic acid; and that this latter agent may asphyxiate independently of the exclusion of oxygen, appears from the experiment of Rolando; he found that the air-tube of one lung of the land-tortoise may be tied without materially injuring the animal; but if one lung were supplied with carbonic acid gas, whilst the other received air, the animal died in a few hours.—(*Carpenter's Human Physiology*, p. 590, 3d Amer. Ed.)

247. Liebig appears to suppose that the poisonous action of hydrocyanic acid and sulphuretted hydrogen, is due to their rendering the iron of the red particles of the blood incapable of absorbing oxygen from the air, and becoming thus the medium of its transfer to the blood and tissues; but to this hypothesis it may be objected, that the blood of an animal poisoned with hydrocyanic acid, exhibits the usual changes on exposure to the air. Sulphuretted hydrogen does seem permanently to injure the composition of the blood, but not of the red particles merely; for it renders the blood fluid, as well as of a dirty red color. It does not seem consistent with analogy, to exclude the fibrine and albumen from a share in the absorption of oxygen, as well as in furnishing the material on which that oxygen afterwards acts.[1]

SECTION XIV.

CHANGES IN THE BLOOD BY EXCRETION.

248. Having already noticed this subject under the head of *diseased secretion* (§ 158), it will be unnecessary to dwell long on it here.

The most remarkable instance of change in the blood from disordered secretion, is exhibited in *defective secretion of urine* (§§ 70, 170). The extreme effects of this element of disease were shown in animals in

[1] The opinion thus expressed in the former edition, corresponds with the views of Mulder, Scherer, and others, subsequently published; but these chemists seem to me to go to the opposite extreme, in assigning to the proteine the chief share in the process of absorbing oxygen. Many facts (§§ 183, 188) combine to prove that the red corpuscles are pre-eminent in their power to absorb and convey oxygen, although it is by no means certain by what chemical property they hold it.

which the kidneys had been extirpated, in the experiments first performed by Prevost and Dumas. On the third day after the operation, there came on vomiting, diarrhœa of a copious brown liquid;[1] fever, with heat varying sometimes as high as 110°, and sometimes as low as 92°; pulse very small and frequent; breathing labored; death ensued from the fifth to the ninth day. After death, there were found effusion of serum in the brain, copious mucus in the bronchi, and bilious fluid and feces in the intestines. The liver appeared inflamed (?) and the urinary bladder much contracted. The blood was more watery than natural (§ 122), and was found to contain urea; five ounces of blood of a dog yielded twenty grains of urea; and two ounces of cat's blood, ten grains.

249. The symptoms induced in defective secretion of urine by degenerative disease of the kidneys, are very similar to those just mentioned, but more diversified, from the defect taking place in different degrees as to amount and time. Thus, in acute cases of albuminuria, or acute aggravations of old ones, there may be epileptic convulsions, low delirium, and other typhoid symptoms passing into coma (§ 129), suffocative catarrh obstinate vomiting, diarrhœa, or inflammatory effusions in the serous cavities, any of which may end in death. In slower cases, cachexia and dropsy may ensue, the blood and solid structures becoming altered. All these effects may be traced to excrementitious matters being retained in the blood, especially urea, which has in very many instances been detected in considerable quantities; in the greatest amount acting on the nervous system as a narcotic poison (§ 129); in smaller, acting as an irritant, inducing low inflammations in various membranes and viscera; and in still lower degree causing sundry functional disorders, fluxes, and dropsies, impoverishing the blood, and inducing degeneration of certain textures (§ 212). It has been already mentioned that the blood in albuminuria loses its proper amount of red particles (§ 185), and of albumen (§ 222), and the diminution of these assists in accounting for the weakness, dropsy, and degenerations which commonly ensue in protracted cases. The several results now enumerated may be differently presented in different cases, and the treatment should be guided according to them.

250. The effects on the blood of a *defective secretion of bile* have not been so accurately determined. The presence of the bile is often obvious in the yellow color of the serum and fibrine, which gives the characteristic green on the addition of nitric acid, and in such cases, analysis has discovered, besides the bilin and the biliphæin, an increase of fatty matter to double or treble the ordinary proportion. In several cases of fatal jaundice connected with structural disease of the liver, I have observed extensive ecchymoses on the legs, which probably are due to the destructive influence exercised by bile on the red particles (§ 187); and I have already stated (§ 171), that in most of the cases of purpura which I have seen, there has been imperfect action of the liver, and the most effectual treatment was by medicines which this circumstance would sug-

[1] From the recent researches of Bernard and Barreswil, it appears that the matter excreted from the intestines contains a quantity of ammoniacal salt, which results from the elimination of urea from their surface.—*Dr. Day's Lectures on Animal Chemistry, Med. Gaz. Sept.* 1847.

gest. The presence of bile in the blood, although sometimes causing tingling, pruritus, and cutaneous eruptions, does not appear to produce local irritation and inflammation, or change of the blood and general dropsy, so remarkably as that of urea does. Still, it appears from very prolonged cases of jaundice, in which the dropsy is not local merely (ascites), but general (anasarca and hydrothorax), that the blood at last is impoverished, and the whole body becomes cachectic. Andral found that in dropsical sheep, with flukes in the liver, the albumen, as well as the red particles of blood, was diminished. Symptoms of giddiness, faintness, and drowsiness, often occur in connection with imperfect action of the liver, such as is commonly designated by the term *bilious attack*, and are relieved by medicines which promote a free flow of bile; but whether they are caused by retention of the excrementitious matter in the blood, or by the sympathy (§ 152) of the brain and heart with the stomach and liver, is uncertain.

251. The *perspiratory secretion* contains lactic acid and lactates of soda and ammonia, which probably proceed from the transformation or decay of the textures, particularly the muscular, which the recent researches of Liebig have shown to contain a preponderance of this acid (*Chemistry of Food*, &c., 1847). Hence these products abound during great muscular exertion; and when perspiration is checked by external cold (§ 77), they may be retained in the blood, causing rheumatism, urinary disorders, or various cutaneous diseases. The very serious effects sometimes resulting from sudden cold on the perspiring body may be partly owing to the same cause, as well as to the disorder produced in the circulation.[1] Rheumatism is especially liable to occur as an effect of cold, where the body is fatigued with much muscular exertion (§ 30); and I have frequently observed that the rheumatism chiefly affects the limbs which have been most exercised. Where the skin fails to excrete, an increased task is thrown on the kidneys, whence may result various diseases of these organs; and if these organs fail in the task, the lactic acid accumulates in the blood, and probably acting as a ferment (§ 56), causes the formation of more, and of the kindred products, lithic acid and its compounds and products; these, in inflammatory subjects, excite rheumatic fever; in cachectic persons, miliary fever, erysipelas, or pemphigus; and in more torpid frames, various local rheumatic or gouty affections. All these cases are frequently remarkable for the acid character of the cutaneous and renal excretions,[2] and in a few instances the blood has been found to possess acid qualities, or to be deficient in its usual alkaline reaction. (*Dr. Day's Vogel* [p. 84, Am. Ed.]). In low forms of rheumatism, especially the neuralgic, the materies morbi is probably oxalic acid, as originally suggested by Dr. Prout, for I have in

[1] Dr. R. Willis has recently suggested that checked perspiration may prove hurtful by rendering the skin dry, and therefore unfavorable for vital changes supposed to take place in the cutaneous capillaries. But if this were the only or chief cause of mischief, it might be always removed by the warm bath, or any other means of moistening the surface; in like manner, pernicious effects should *always* result from a dry state of the skin; neither of these consists with facts.

[2] In patients with acute rheumatism, I have frequently found the perspiration of the affected joints more strongly acid than on other parts.

numerous instances found an abundance of the octahedral crystals of oxalate of lime in the urine, especially when the patients begin to convalesce.

252. The remedy for rheumatism and other diseases arising from defective excretion, therefore, should not be merely antiphlogistic, but also of a kind calculated to eliminate the morbid matter from the blood. In slight cases of rheumatism, sudorifics may suffice; but in others, the kidneys and liver should also be excited to assist in the process of elimination, and various combinations of colchicum and alkalies with mercury, opium, and iodide of potassium, will generally effect this purpose very satisfactorily, and both speedily and permanently remove the disease.[1] Where the disease is more decidedly asthenic, and the urine exhibits a deposition of oxalate of lime with or instead of lithates, or acid phosphates, great advantage may be often derived from the use of means calculated to raise the tone and vital energies of the circulating and secreting organs, such as bark, quinia, arsenic, and iron; and they are the more eligible in cases of neuralgic rheumatism, because the attacks are periodic, with intervals of depression highly favorable to the use of these remedies.

SECTION XV.

CHANGES OF THE BLOOD FROM THE TRANSFORMATION OF CHYLE AND OF THE TEXTURES.

253. The changes of the blood from the transformation of the chyle and of the textures, including the processes of nutrition and reparation, have been examined too little to supply the pathologist any certain data. Prout, Liebig, and other organic chemists, have advanced interesting views on these subjects, but they are too hypothetical to be strictly applicable to medicine. It seems quite warrantable, however, to connect with these changes some remarkable states of disease, on the pathology of which chemistry has thrown much light, *gout* and other *lithic acid diseases* (§ 176), *diabetes*, both *saccharine* and *ureal*, and *obesity*.

254. Gout, and the commonest kind of urinary gravel, are now generally considered to depend on the production in the system of an excess of lithic acid.[2] This acid being a highly azotized compound, is abundantly generated in those who take a large proportion of animal food, and in whom the digestive and assimilative processes are impaired; and

[1] The advantages of this due regard to the essential elements of disease in the treatment of rheumatism, may be shown by the fact, that, in upwards of two hundred cases of various forms of rheumatism, under my care in University College Hospital, the convalescence was established in from three to six days on an average, and the patients were dismissed cured in from one to three weeks after.

[2] This view, although generally admitted on inferential evidence, has lately, for the first time, received a demonstration of its truth, in the case of a gouty patient of mine at the hospital, in whose blood Dr. Garrod readily detected the presence of lithic acid. The case was of chronic gout; and farther illustrated the pathology of the disease, by a total absence of lithic acid in the urine, until during the exhibition of colchicum, when its characteristic crystals appeared under the microscope.

the more the processes are weakened, and the less digestible and assimilable the food supplied to them, the more surely will this acid with ammonia, the products of degenerating decomposition, result. Hence it is engendered not only as a consequence of general full living and sedentary habits, but especially from highly-seasoned and over-cooked meats, cheese, pastry, strong acid wines, &c.; and the avoidance of such articles is a more effectual safeguard against gout, than general abstinence, which, in many cases, is absolutely hurtful. Lithic acid is one of the lower forms of animal matter into which the higher principles, fibrine, albumen, gelatine, &c., tend to pass, in their progress towards dissolution. Hence it is produced in excess, where there is more azotized matter than is wanted for the reparation of the textures, or than the vital assimilating powers can appropriate for this purpose. But it probably results also from the decay of the textures, especially during febrile or inflammatory irritation, during and after which copious deposits of the lithates are seen in the urine.

The morbid effects of an excess of lithic acid will vary considerably, according to its amount and other circumstances. The kidneys are the proper emunctories by which it is eliminated from the blood, and these sometimes suffer from the irritation which it causes; hence nephralgia and nephritis[1] may occur; or the water and alkali secreted with it in the urine may be insufficient to hold it in solution, and it may be deposited in the form of crystallized sand or gravel, or calculus, in the kidneys or bladder; and various irritations and obstructions in the urinary apparatus may be the result.

But sometimes the kidneys may fail in their power of elimination (§ 170); the lithic acid and its compounds then accumulate in the blood, and may cause various irritations and functional derangements (irregular gout, which is extremely common, and of infinitely various form and seat), until at length some circumstance may fix the irritation in a limb, and a fit of regular gout is the consequence. In this fit, if perfect, inflammation is excited with more or less febrile disturbance, which ends with a copious deposit in the urine, showing the removal of the morbid matter (§ 165). The more acute and fixed the inflammation, and the smarter the fever, the more abundant is the deposit, and the more free is the patient from disease afterwards. On the other hand, when the inflammation is low, changing its place, and with little fever, it generally tarries long, and the system is not relieved. It is when gout thus lasts long, or frequently recurs, that often its material so accumulates in the joints as to be deposited in the form of a plastery or calculous matter, consisting of lithate of soda (chalk stones of gout).[2] This chronic form of gout is connected with a more or less permanent dis-

[1] I have in several instances found in the cortical and tubular structure of the kidney, clustered crystals of lithic acid, which, under the microscope, exhibited such sharp angles and dagger-shaped projections, as would afford an easy explanation of the pain, inflammation, and hemorrhage, often attendant on an attack of renal gravel, even when none is obvious in the urine.

[2] A case of chronic gout at present (June, 1847) under my care, has afforded an opportunity of verifying this observation; the matter obtained by puncturing the white tumors of his fingers, is of the consistence of thick cream, and consists of very fine acicular crystals of lithate of soda, with a trace of lime.

order of the digestive or assimilative functions, which renders its treatment more difficult or less successful than that of the more acute forms of gout. In such cases (chronic), lithic acid seems to be engendered in great abundance, and although thrown off in large quantities in the urine for an indefinite period, yet never leaves the body free. Such cases are commonly either hereditary, or those which have been rendered inveterate by intemperate habits, or neglect of proper treatment.

255. In saccharine diabetes, the morbid matter is of a nature quite contrasted with that of gout and gravel, being grape sugar, which is wholly unazotized; yet this is also probably produced in connection with the processes of digestion and assimilation—the condition of the urine being only a consequence of disorder in these processes. The analyses of Ambrosiani, Maitland, and others, have proved the existence of sugar in the blood of diabetic patients, the specific gravity of the serum of which may rise to 1060 from its presence; and Macgregor has also established the fact of its unusual production during the process of digestion. The facility with which, in the laboratory, starch and gum can be converted into sugar, especially under the action of acids, throws much light on the origin of sugar in diabetes; and the actual presence of a very large amount of acid in the stomach in diabetic patients, confirms this mode of explanation. The appearance of sugar in the urine can scarcely be considered otherwise than as a result of its presence in the blood. But it is probably formed not only from isomeric principles in the food, such as starch and gum, but in confirmed cases it is also derived from a decay of the textures, especially the gelatinous, by a modification of the process in which urea is naturally evolved, as it has been found practicable to convert gelatine partially into glucocol, which has saccharine properties, and probably consists of sugar and urea. As there is saccharine matter naturally in chyle (and even in blood, for a short time after the chyle is added to it), it might be supposed that there is, in incipient diabetes, an exaggeration of the process by which saccharine matter is formed; and this is countenanced by the fact, ascertained by Bouchardat, that the sugar in the blood of diabetic patients is at its maximum during the process of chylification, and that it almost disappears after a long fast.[1] It is, therefore, probable that the atrophy and cachexia accompanying the disease, result from the draining away of the nourishment of the body *with* the excess of sugar, rather than the conversion of all this nourishment *into* sugar. It is now well ascertained that the ordinary animal constituents of the

[1] [The contradictory results obtained with regard to the presence of sugar in the blood of diabetic patients, is due, chiefly, according to M. Bouchardat, to the following circumstance. If you examine diabetic urine at different periods of the day, you will find that an hour or two after meals it is abundantly secreted, contains a considerable proportion of sugar, which successively decreases for the next twelve or fifteen hours; beyond this term, if the patient has eaten nothing, no trace of sugar will be found in the urine. Patients are ordinarily, in hospitals, bled in the morning, the period most distant from their meals, and the amount of sugar then in the blood is so minute as to escape detection. By two comparative analyses, M. Bouchardat sustains his position. In a patient, bled at nine o'clock in the morning, who had fasted since five o'clock the previous evening, no trace of sugar was detected. In another patient, bled two hours after a light breakfast, there was unequivocal evidence of sugar in the blood. These observations of M. Bouchardat have been corroborated by Simon.—C.]—*Animal Chemistry*, p. 267, Am. Ed.

urine are not only present, but are often increased considerably beyond their natural amount.

256. There is a parallel between the indications of *treatment* in gout and in diabetes, although, in the fulfilment of these indications, the means to be employed are most opposite. In both cases we must withhold those articles of diet from which the morbific matter is most readily generated. Thus abstinence from animal food and stimulating condiments and beverages, in the case of gout—the exclusive use of these very articles, to the avoidance of all saccharine or amylaceous substances in the case of diabetes—constitute a successful part of the treatment. In both cases, it is indicated to improve those processes of digestion and assimilation from a perversion of which the morbid matter is probably generated. But, unfortunately, we know too little of these processes and of means which may influence them, to enable us to fulfil this indication with certainty. A gouty constitution, in the absence of the febrile paroxysms, is often much corrected by the use of bitters and other mild tonics; and in diabetes, an amendment occasionally takes place during the exhibition of opium and some of the stronger astringents and tonics, such as preparations of iron, copper, &c. In both gout and diabetes, the mal-assimilation seems to be connected with an unusual development of acidity in the system, and in both diseases alkalies have been found to be useful; and for reasons presently to be mentioned, soda and potass are more suited to gout, and ammonia and magnesia or the alkaline phosphate of soda, succeed best in diabetes. To take full effect alkalies must be given largely, in the form of their carbonates.

In the effect which each exerts on the economy, there is a great difference between the morbid matter of gout and that of diabetes. The sugar in the latter has no tendency to accumulate in the system and produce local effects; but, acting as a powerful diuretic, it passes rapidly away, carrying with it a great quantity of water, and of the other constituents of ordinary urine (§ 165); and the thirst, dry skin, and emaciation of diabetes, seem to be chiefly due to this mode of operation. The common complication of diabetes with pulmonary consumption shows also, however, that the plastic process is degraded (§ 211).

The lithic acid of gout and gravel, on the other hand, has a tendency to accumulate in the body, and to cause the local and general irritations which have been already mentioned (§ 254). Hence it becomes a chief indication to counteract its irritating properties, and to promote its elimination from the system. The medicines which are most efficacious in doing this are alkalies, or their carbonates, or their vegetable salts, with colchicum, or iodide of potassium, saline mineral waters, and alterative aperients. These all increase the action of the kidneys and intestinal canal, and drain off the offending matter from the system; but the operation of colchicum is far more certain than that of the others; and its permanent efficacy depends on its continued action on the kidneys in particular.

257. It is supposed by most chemists, that the urea excreted by the

kidneys is chiefly derived from the transformation or decay of the textures of the body (§ 254), most of their carbonaceous matter being abstracted by the affinity of the oxygen of the blood, and carried off by the lungs in the form of carbonic acid gas (§ 232). The causes which increase the production of urea are, according to Liebig, those which excite the activity of the function of respiration, which supplies the consuming oxygen, especially active bodily exercise. Under some circumstances, however, the formation and excretion of urea are much augmented, without any obvious excitement of the respiratory function. This is the case in the diabetes ureosus described by Dr. Prout, and which he considers a forerunner of saccharine diabetes. Such spontaneous production of the matter which seems to be a kind of debris of the body, indicates organic debility, or exhaustion of the vital powers, and has been observed to occur in young persons who have grown rapidly, or in those weakened by great mental exertion and want of sleep, or by venereal excesses. An excessive excretion of urea (or of carbonate of ammonia, which is of kindred composition), sometimes takes place in typhoid fevers, and is attended with great loss of flesh and strength. A great and sudden increase of urea in the urine was ascertained to have taken place, in some patients with acute rheumatism, and others with delirium tremens, in University College Hospital, at the decline of the fever and other acute symptoms. This perhaps ought to be viewed as arising from the removal of that which had accumulated, rather than from an increased formation of urea; and this fact may be connected with that ascertained by Professor Chelius and Dr. Lewins, that colchicum causes an augmented discharge of this and other principles of the urine (§§ 173, 252).

In cases of excessive formation of urea, all circumstances which depress or exhaust the organic life must be avoided, such as great excitement of body or mind; waste must be supplied by a generous diet, and the nutritive function sustained by tonics. Opium and other narcotics are found to be useful in reducing the urine in the diabetes ureosus; and they probably operate by calming exhausting nervous excitement, and procuring sleep.

258. The eduction or production of fat from food takes place with remarkable activity in some persons; and wherever it obstructs or supersedes the proper formation of fibrine and other proteine principles more immediately concerned in giving strength to the bodily frame, it amounts to disease. The circumstances in the diet tending to this result, have been formerly noticed (§§ 59, 60), and we have had occasion to mention that sedentary habits and a lowered condition of the respiratory function, have sometimes a similar effect (§§ 65, 239). But in connection with our present subject, there are many reasons for supposing that an excessive production of fat sometimes occurs as an error in assimilation, and may interfere with the sufficient production of other animal principles and with the nourishment of the textures of kindred composition, whilst fat accumulates not only in its proper texture, but invades others, lowering their vitality and cohesion, and thus constituting a cause of gradual degeneration. Thus Mr. Gulliver has shown that the atheromatous patches in the coats of arteries, which appear to be a mark of declining age (natural or premature), are of the nature of fatty degeneration. The

same pathologist has discovered a predominance of fatty matter (chiefly oleine, margarine, and cholesterine), in the lungs, the kidneys, and testicles, under various chronic diseases (*Med. Gazette*, June, 1843). A similar abundance of fat has been frequently observed by me (first in conjunction with Dr. R. Quain, in May, 1845), in the kidneys, liver, and other structures of persons whose habits of excessive intemperance proved fatal, with symptoms of general cachexia and failure of many functions. This subject will be noticed again under the head of *perverted nutrition*, where the remedies to be opposed to the element, fatty transformation, will be considered.

SECTION XVI.

CHANGED PROPERTIES OF THE BLOOD FROM THE PRESENCE OF FOREIGN MATTERS.

259. The blood is probably the chief seat of the morbid poisons which excite various contagious (§ 93), epidemic (§ 88), and endemic diseases (§ 81). Probably, too, it is the hotbed in which some of them are propagated, whether by seeds, ova, cell-germs, or parasites (§ 99); and it is through changes in its composition that many of the destructive effects of these poisons are produced (§§ 186, 196). We have already noticed some of these changes under former heads. It will suffice in this place to mention a few examples in which morbid poisons have been traced to the blood.

Dr. Francis Home communicated measles from one person to another by inoculating with the blood of a patient affected with the disease. M. Gendrin describes the following experiment: A man who had been skinning a diseased animal was seized with a putrid fever, attended with an eruption of sloughing pustules. Some blood taken from this man was injected into the cellular texture of the groin of a cat; the animal was soon affected with vomiting of bile, dyspnœa, frequent, small, and irregular pulse, dry brown tongue, slight convulsions, and died seven hours after the injection. The same pathologist produced in animals various severe symptoms, speedily ending in death, by injecting into their veins blood from a person laboring under confluent smallpox. MM. Dupuy and Leuret communicated to a healthy horse the malignant postular disease called "charbon," by injecting into its veins blood from a diseased animal; and M. Renault, in a similar way, propagated glanders from one horse to another. Andral quotes from Duhamel an extraordinary case, in which blistering, pustules, malignant fever, and death, followed the mere contact on the lips of the diseased blood of an animal. Other instances are on record of sickness, faintness, and serious illness being caused by the odor of blood; and Dr. Copland quotes from Zacutus a marvellous story of three persons being struck dead by the smell of the blood of a patient in the plague.

There is good reason to suppose that purulent matter and the germs (§ 90) of carcinoma, and other forms of malignant disease, are spread

through the system through the medium of the blood. Pus has been frequently detected in the blood by the aid of the microscope, first by Mr. Gulliver, and by many subsequent observers. The pus-globule is to be distinguished from the pale or lymph-corpuscle, by its somewhat larger size, more distinct and often granular cell-wall, by its contained granules or nuclei being more distinct, and sometimes loose in its interior; and lastly, by its exhibiting exosmotic and endosmotic properties much more actively. The different effects of pus in the blood will be noticed under the head of *results of inflammation*. The tendency to symmetrical arrangement which cutaneous eruptions, nodosities of the joints, paralysis from lead, and some other local affections, exhibit, has been adduced, by Dr. W. Budd and others, as an instance of effects produced through the medium of the blood—the symmetrical distribution of this fluid on the opposite halves of the body leading to like results in corresponding parts.

260. In the *treatment* of this element of disease, *foreign morbific matters in the blood*, the two indications which present themselves are: 1. To counteract the injurious operation of these matters; and, 2. To expel them from the system. The first of these indications is followed, when we give stimulants to overcome the depressing influence of adynamic fevers and other sedative poisons; antiperiodic tonics to prevent the operation of the paludal poison (§ 81); and when opium and other narcotics are administered where irritation prevails. We do not possess chemical antidotes which can act on the foreign matter in the blood without injuring the blood itself. The other indication is more generally pursued, although little recognized by practitioners—to expel the offending matter from the system. The excretory organs, especially the kidneys and alimentary canal, are the natural emunctories through which foreign and offending matters are expelled from the blood; and hence the utility of alterative aperients and diuretics (§§ 173, 174), in the treatment of fever and other diseases connected with poison or injurious matter in the blood. Orfila found that the pernicious effects of small repeated doses of arsenic in animals might be averted by giving, at the same time, a diuretic medicine. Let us bear in mind how often fevers and other serious ailments seem to be carried off by spontaneous diarrhœa, diuresis, or perspiration; and, perhaps, sometimes by these discharges artificially excited. Nor should a converse fact be overlooked, that persons affected with diseases of the kidney, which impair its excernent function, are peculiarly liable to contract infectious diseases, and to suffer from their effects (§§ 17, 26, 32). Similar observations may be made respecting various other poisons which operate through the blood, such as opium, arsenic, mercury, &c., which operate with uncommon, and therefore dangerous energy, on those whose excreting functions are much impaired.

CHAPTER III.

SECONDARY OR PROXIMATE ELEMENTS OF DISEASE, CONSISTING OF TWO OR MORE PRIMARY ELEMENTS (§ 304).

SECTION I.

ANÆMIA.

261. THE class of *proximate* elements which have been most generally studied as the subjects of general pathology, are those affecting the circulation of the blood. They comprise at least three of the *primary* elements which have been considered—the blood and its constituents, the irritability and the tonicity of the organs (§§ 110, 120), concerned in its distribution. A previous acquaintance with these elements will render very intelligible many of the kinds and phenomena of their compounds, but it is necessary to keep in view also the physical properties of the vessels and their contents; for these properties, when altered, become elements of disease. Thus a mechanical obstruction or an enlargement of a bloodvessel contributes to the formation of disease as much as a change of vital properties. So it is impossible to understand the effects of too much or too little blood in the vessels, without a due consideration of the mechanism of the circulation.

We shall briefly consider the morbid conditions connected with *defect* and *excess of blood* in the vessels, under the divisions of *general* and *partial*, and as attended with an *increase* or *diminution* of the irritability and tone of the moving fibre. It is to be understood that all the proximate elements of disease now to be considered, may occur either as distinct affections or in combination with other maladies.

262. *Anæmia*, or as it has been more correctly termed, *hypæmia*, or *aligæmia*, is the name applied to that condition of the system in which the predominant character is a *deficiency of blood*. And as, together with this deficiency in quantity, there is very generally a remarkable deterioration in its quality, the late Dr. Simon applied to the condition the term spanæmia (σπανος, poor).

263. The exciting causes of anæmia are, various circumstances which withdraw or injure the blood, especially the red particles (§ 71), or interfere with their formation (§ 66); such as excessive bleedings, or hemorrhages; profuse evacuations of other fluids, which contain much of the

animal parts of the blood; scanty or poor food, especially that which contains little animal matter or proteine; confinement in impure air, dark places, or malarious districts (§ 191); certain chronic maladies which deeply affect the constitution, such as tuberculous and cancerous diseases, and granular degenerations of the kidneys (§§ 185, 222, 249); but the commonest cause of all is irregularity of the uterine function, which induces the common form of the disease long familiar under the designation *chlorosis*. It might seem difficult to understand how the last operates; but that, in many cases, it is a cause and not an effect of anæmia, is plain from the well-known fact that no signs of anæmia have occurred until cold, over-exertion, or mental excitement, or some circumstance, has suddenly checked the flow of the catamenia; it has not returned; and then the patient begins to lose color, and gradually to exhibit the anæmic state. In many cases, I have known this occur in young females who have previously suffered from acute rheumatism, implicating the heart. It would seem that, in these cases, some injury is done to the blood-particles, and to the powers by which they are repaired; this is manifest not only from the pallidity, but from the yellowish and almost greenish hue which the complexion sometimes presents, and which obviously depends on a discoloration of the textures by the altered blood, as in the neighborhood of a bruised part. The nature of these changes has been already noticed (§§ 185–6, 191). In some of these cases of chlorosis, the appetite is depraved (§ 131); there is such a complete disrelish for animal food and other nourishing articles, and such a craving for sour things, and even for matters destitute of nourishment, as chalk, cinders, &c., that it might be supposed that this perverted appetite is the cause of the anæmia, by deterring the patient from taking that food which is capable of making red blood; and undoubtedly such an appetite, when indulged, must contribute to this result; but it is not so constantly present as to be considered the chief cause of the anæmia in the examples under consideration.

It is often symptomatic of various maladies, particularly chronic and cachectic affections; but it sometimes occurs without any other known disease, and its symptoms exemplify in a striking manner the mode in which the various functions suffer for want of a due supply of the vivifying fluid (§§ 183, 185).

Thus the general symptoms of anæmia are those of weakness (§ 116); general muscular weakness, evinced by the faintness, breathlessness, and fatigue caused by exercise; weakness of the heart, shown by the feeble, loose, or thready pulse, rendered very frequent and palpitating by slight exertion, and often irregular and failing afterwards; feebleness of the whole circulation (§ 123), manifest in the coldness of the surface and extremities; organic weakness, shown by the loss of appetite, indigestion, torpor of the bowels, scanty and disordered secretions (§ 172); defective nutrition (§ 211), especially of the muscular parts; and imperfect sanguification; for the remaining blood becomes diseased, being poor and watery, as well as scanty (§§ 185, 222).

264. There are also distinctive physical signs of the scantiness of blood in the body; the surface is remarkably pallid, and even the lips, gums, and tongue show none of their healthy ruddiness. The complex-

ion may vary the amount and kind of the paleness, dark persons often appearing very sallow, or even of a yellowish or greenish tint, and those of fair complexion having a ghostly paleness. If bloodvessels are seen at all, it is only the larger superficial veins, which are pink instead of blue, from the paucity and transparency of the blood in them. In the course of the larger veins, especially the jugulars in the neck, the thin blood, running with great rapidity in the ill-filled vessels, is often thrown into sonorous vibrations (venous murmurs), which are sometimes sensible to the finger placed lightly on the vein. The same thinness of the blood, together with an abruptness in the heart's contractions (§ 113), frequently causes a murmur with the first sound of the heart, referable to the aortic orifice; as, however, this murmur varies much in different cases, being scarcely audible in some, whilst it is loud and harsh in others, it is obviously dependent in part on some irregularity or narrowing at the mouth of the aorta, too trifling to give any obstruction or sound when the blood is abundant and of due spissitude, but readily causing vibrations and sonorous gushes when the fluid is thin, and the relations between the size of the heart and arteries somewhat changed.

265. The blood, when drawn, is very thin and watery. It readily coagulates, and forms a very small contracted clot (§ 207), generally covered with a buffy coat. This appearance is probably due, as Andral surmises, to a predominance of the fibrine over the red particles, for these are diminished much more than the fibrine, being, in extreme cases, reduced to one-fifth of their natural proportion (§ 185). The albumen is also generally scantier than usual; a remarkable exception in the anæmia attendant on paraplegia has been already noticed (§ 221).

266. Although the symptoms of anæmia are chiefly those of great weakness or depression (§ 262), there are often others of an opposite character, indicating irritation or exaltation of function. Some of these arise indirectly from the weakness; as, for example, pain in the left side and epigastrium, nausea, colic, and diarrhœa (§§ 56, 168, &c.), which may be traced to the weak digestion leading to the production of sundry irritating matters, from that which has been used for nourishment. But other more direct signs of excitement sometimes occur. Thus various properties of the nervous system are sometimes exalted; sensibility is acute (§ 126); there is intolerance of light and sound, with flashes in the eyes, noise in the ears, a sense of rushing in the head, and various neuralgic pains. The excito-motory nerves are sometimes excited (§§ 140, 150); and spasms, or convulsive affections of different kinds, may be present; or the organic functions may be affected; and palpitation, spasmodic asthma, vomiting, and such sympathetic irritations may occur. In a few instances, anæmia has been attended with delirium, or mental excitement bordering on it.

267. It thus appears that the functions which frequently are thus excited in the midst of general depression and weakness, are those of the nervous centres; and the generally nervous character of persons in a state of great weakness (§ 113), is connected with the same fact, so that *nervousness* and *weakness* are almost synonymous terms. No explanatión of this apparent anomaly has been, to my knowledge, proposed; but one seems to suggest itself in the peculiar distribution of the circu-

lation through the nervous centres. When the mass of the blood is reduced in quantity, the bloodvessels generally contract in proportion, their tonicity adapting them to the amount of their contents (§ 120). But the vessels within the skull and spinal canal cannot contract with the same facility; for not being exposed to atmospheric pressure, and some of them being fixed in bony canals, they do not shrink as the blood becomes reduced, and therefore they retain more than their proper share of the circulating fluid.[1] This disproportionate amount of blood in the nervous centres, produces different effects, according to the degree which the heart's propulsive power (§ 111) reaches it. Under the influence of temporary palpitation (§ 112), fever, or other kind of excitement, the brain and spinal cord, through their uncontracted vessels, which are among the nearest to the heart, receive an unusual share of its exalted but partial force; an erethism of some one or more of the functions of these nervous centres (§§ 127, 133, 153) is the consequence; and pain, spasm, sensorial excitement, intolerance of light and sound, or sympathetic irritations of some kind or another, occur.[2] In this condition, the head may be hot and throbbing, the face flushed, the eyes suffused, whilst the extremities and the surface generally are comparatively bloodless, and either cold, or very speedily becoming so, on exposure. Epistaxis sometimes occurs, and, although bringing momentary relief, may, if considerable, add to the evil, by increasing the anæmia.

268. On the other hand, if the heart's action is feeble (§ 116), it may be inadequate to propel the blood accumulated in the vessels of the brain; it therefore stagnates, and may cause some of the symptoms of congestion in that organ. Hence headache and giddiness, relieved by the recumbent posture, drowsiness, impaired mental faculties, obscured vision and hearing, partial paralysis, and in extreme cases, coma or catalepsy (§§ 129, 133, 141). In such cases, the blood is accumulated more in the veins and sinuses of the brain than in its arteries, and not receiving enough force from the heart to keep it in full motion, it partially stagnates, and the functions of the corresponding parts are impaired in proportion. This congestion may be only temporary, and lead to no serious results; but in some cases I believe there occurs an event that has not been noticed by pathologists—namely, a coagulation of the blood in the sinuses, and a consequent permanent obstruction to

[1] This statement is not invalidated by the recent experiments of Dr. G. Burrows, (*Med. Gaz.* April, 1843, [*Disorders of the Cerebral Circulation*, &c. &c., Phil. 1848.]) His experiments and expositions very satisfactorily demonstrate the absurdity of the notions, founded on Dr. Kellie's paper, that the quantity of blood in the head is always the same; but it remains clear, that the circulation within the head and spinal canal, especially in man, is affected by losses of blood differently from the circulation in other parts.

[2] Although the chief effect of excitement of the circulation in anæmia is thus directed to the nervous centres, it is by no means confined to them. Other parts, in the immediate vicinity of the heart, become the seat of increased arterial pulsation and disturbance. Thus, a painful throbbing is often complained of in the throat, chest, and epigastrium, even when there is little pulse in distant arteries, and the extremities are cold. To understand these facts, we must bear in mind that when the arteries are full and tense, they oppose their fulness and tension to each contraction of the heart, which resistance reduces the strength of each pulse in the vicinity of the heart, although it continues to propagate it to a distance; but when the arteries are empty and loose, the heart squirts to them the blood in an unresisted jet, the force of which is strong near the heart, but extends not to distant arteries.

the passage of the blood through the brain. I have met with several cases more or less corresponding with the following description.

A young female becomes anæmic, and after exhibiting various symptoms of feeble general circulation, with headache, drowsiness, and impaired sensorial functions, suddenly becomes worse; passes into a state of stupor with dilated pupils, sometimes varied by slight manifestations of delirium, throbbing of the carotids, and partial heat of the head, and dies comatose. On opening the head, a small quantity of serum is found under the arachnoid and in the ventricles, sometimes with a little lymph (in one case there was none). The vascularity of the membranes is remarkable, but the vessels most distended are the veins; and in the larger of these, and in the longitudinal sinus, there is a firm coagulum. In parts, especially at the torcular Herophili, this coagulum blocks the whole sinus, and exhibits a separation of fibrine, portions of which are softened down into that opaque purilaginous matter which was long mistaken for pus, but which Mr. Gulliver has shown to be a mere disintegration of the fibrine which mere stagnation in a warm temperature may effect. These have been taken for cases of meningitis. No doubt inflammation may supervene in them occasionally, but in two cases that have fallen under my notice, there was no adhesion of the arachnoid nor deposit upon it, nor any other unequivocal mark of inflammatory action, yet the fibrinous and bloody concretions in the veins and sinuses were most remarkable for their size and firmness[1] (§ 213).

It appears to me most probable that these affections originate in the encephalic congestion connected with anæmia. Fibrinous concretions form on the transverse bands of the sinuses, and increase until they considerably obstruct the passage of the blood; hence the impaired state of the cerebral functions, amounting at last to coma. Reaction (§ 16) may take place, with determination of blood, and even inflammation, and these cause those symptoms of partial excitement that sometimes exhibit themselves; but neither during life, nor on examination after death, are the proofs of excitement so prominent as those of obstruction and interruption to the cerebral functions. It must be remembered that in anæmia the fibrine of the blood is not diminished in the proportion of the other animal contents, and it has a greater tendency to coagulate than in healthy blood (§ 207).

269. In anæmia of long duration, the process of nutrition often suffers (§ 211), but by no means uniformly. The cornea sometimes becomes ulcerated; probably because, being a non-vascular texture, it the more needs a nourishing quality of the plasma. The muscles become flabby and attenuated; wounds and fractures sometimes do not readily unite; and, in some instances, spreading ulcers and sloughy sores form spontaneously on the surface. Emaciation is, by no means, a constant result of anæmia; and it is not uncommon to see the most pallid subjects, especially females, retain a considerable amount of fat. Dropsical effusion into the cellular texture is a common result of anæmia, when

[1] A wax model of the sinuses and membranes in one of these cases, is in the museum at the University College. Cruveilhier gives a representation of a similar case, which, without sufficient reason, he considers as one of cerebral phlebitis. Andral mentions a case of cerebral hemorrhage in connection with anæmia, which was probably of the same kind.

either long continued, or aggravated by additional causes which disturb the circulation (§ 222). The researches of Chossat on the effects of inanition on animals, are, in some measure, applicable to this subject; for anæmia is the result of deficient food (§ 63). He found that defective nourishment notably reduced the weight of all the structures of the body, except only those of the nervous system, which were wonderfully little diminished by it. This fact accords with that of the remarkably predominant activity of this system in persons weakened by low diet and similar causes, and is well explained by the manner in which the vessels supplying the nervous centres monopolize the blood, as indicated in a preceding paragraph (§ 267). Hence this ascendency of nervous function, which was first a temporary result of irregular circulation, becomes in time permanent from comparative change of structure; and the condition which at first might have been obviated by means which regulate the flow of blood, assumes the fixedness and intractability of structural disease.

270. Anæmia, in its extreme degrees, may prove fatal suddenly by syncope (§ 71), brought on by exertion, or any additional cause of exhaustion; or, more gradually, by asthenia, or general failure of the vital powers, often attended with anasarca; or, by developing tuberculous (§ 211), or other cachectic diseases, to which the individual may be predisposed; by the singular affection of the head before noticed (§ 267), or by slower and less marked changes in the nervous centres, leading to paralysis, insanity, amentia, epilepsy.

[The fundamental and constant character of anæmia, is the diminution of the red corpuscles of the blood. Women are more subject to it than men, although these may be attacked with spontaneous anæmia at all ages. The clot is small, but firm and dense, swims in a large quantity of colorless serum, and presents on its surface a well-marked buffy coat, which, however, differs from the buff of inflammatory blood by a gradual termination in the red mass, and not by an abrupt, well-defined line. (This is due to the excess of fibrine relatively to the globules.) When the red corpuscles are below 80, according to Andral, the bruit de soufflet in the arteries is a constant phenomenon. It is often heard when their cipher oscillates between 80 and 100, and becomes more rare as the physiological mean is approached, and, when it is reached, ceases altogether. Whatever other disease, besides anæmia, in which this diminution of the red corpuscles exists, we have this phenomenon; in putrid and eruptive fevers, pneumonias, acute articular-rheumatism, and in a great variety of chronic diseases. The bruit de soufflet is often present in pregnant women, and corresponds with the frequent diminution of the red globules in them.

In spontaneous anæmia, the red corpuscles alone are affected, the other sanguine elements remaining intact; subsequently, however, they may become likewise compromised.—C.]

271. *Remedial Measures.*—Most of the measures useful for the treatment of anæmia, have been already described as those suitable to restore a deficiency of red particles and fibro-albumen (§§ 193, 216). A nourishing diet, with as much animal food as the digestive powers of the patient can master—tonics that best restore the appetite, the powers of diges-

tion and sanguification—the use of means, if necessary, to promote the natural excretions (§§ 172, *et seq.*, 191), and an exposure of the patient to the pure air and light of heaven, as free and as long as the strength and sensibility will bear, form the chief items of the treatment.

The adaptation of this treatment to particular cases will require much discretion, especially in proportioning the food to the faculty of digestion, and in selecting a tonic that shall not irritate. Where it does not disagree, iron, in some of its forms, is unquestionably the best tonic: and in many comparative trials, I have found the iodide of iron (in solution with syrup) the most speedily efficacious. Besides its tonic action, it promotes the secretions more than other combinations of iron, and in some way, like other preparations of iodine, increases the freedom of the capillary circulation; by its use, I have seen females restored from extreme pallidity to a rosy hue of health in less than three weeks. The sesquioxide, citrate, tartrate, and ammonio-chloride, are more tardy in their operation; and the sulphate and sesquichloride are apt to nauseate, or otherwise disagree; but each is found occasionally useful, and so are chalybeate mineral waters. In some cases, any preparation of iron causes headache, fever, sickness, or some other symptoms of disorder; and then milder tonics, as columba, or other bitters, with mineral acids, or with iodide of potassium, are more suitable at first; and the stronger tonics, with iron, may be given afterwards. In extreme cases, as those after excessive losses of blood, I have found it very useful to give sulphate of quinia at the same time as the iodide, or some preparation of iron.

The success of the treatment becomes manifest, not only in the return of a healthy color to the lips and skin, size to the superficial vessels, and strength to the pulse, but also by an improvement in all the functions, breath, strength, digestion, &c. It is a curious fact that the venous murmurs (§ 263), although diminished, are not so in proportion to the apparent return of color to the surface; I have before given reasons for considering them to depend on deficiency of albumen, as well as of the red particles. This does not accord with the opinion of M. Andral, who reckons the vascular murmurs to be a true exponent of the deficiency of the red particles only; but this, as a matter of observation, loses weight from the erroneous notion which he, in common with Bouillaud, holds as to the true seat of these murmurs. They believe them to be in the carotids only; I several years since was satisfied, from numerous and varied experiments, that Dr. Ogier Ward's opinion, that the loudest murmurs are in the veins, is correct. I may add, that they are to be accurately investigated only by the flexible ear-tube recommended by Dr. Stroud.

272. Besides these general measures, indicated for all varieties of anæmia, particular cases require temporary measures, on the one hand, to prevent faintness or excess of weakness (§ 262); on the other, to subdue nervous excitement (§ 265), and counteract the congestion in the head, which we have found to occur (§ 267). Diffusible stimulants, such as carbonate of ammonia, valerian, ether, wine, and spirits, are often useful as temporary means of obviating the extreme weakness. Symptoms of nervous excitement (§ 26) require nervous sedatives and nar-

cotics; such as hydrocyanic acid, hyoscyamus, belladonna, conium, &c.; whilst those of nervous depression indicate the use of such stimulants as are found to excite the nervous energies, such as the fetid gums, oil of turpentine (especially in enema), strong tea and coffee, cantharides, strychnia, electricity, &c. (§§ 130, 155). But, inasmuch as these very symptoms seem to depend on the irregular distribution of the little blood left in the body, they will be the most effectually relieved by reducing this irregularity, by the unremitting maintenance of warmth in the surface and extremities, aided by occasional friction, rest in the horizontal posture, varied with such gentle exercise as the patient can bear; with pure air, and the judicious use of tepid or cold sponging, or shower-bath, especially directed on the head and spine (§ 124). The symptoms of decided cerebral congestion and obstruction have generally been treated by antiphlogistic remedies, but with questionable advantage. I have found more benefit to result from a mild stimulant and tonic plan, together with more or less powerful derivants, purgatives, and saline diuretics. Such a plan commonly answers best in the congestive headache which often troubles anæmic subjects. Depletion is often earnestly called for by the patient; but it should be avoided as much as possible; where absolutely required, from the urgency of the symptoms, cupping to the nucha, or leeches to the temples, or, what is more effectual, two leeches to the interior of the nostrils, will answer best. Persons who have long and severely suffered from anæmia, especially from excessive and repeated losses of blood, or from menorrhagia or uterine hemorrhage, or from inordinate lactation, do not lose their nervous symptoms in proportion as their blood is restored; and this I would ascribe to the structural change which has ensued, as before described (§ 268). The treatment necessary in such cases is of a permanent kind, avoiding all causes of nervous excitement, and using those various means, medicinal and regiminal, which have been formerly recommended as useful in reducing nervous excitability (§§ 128, 155). Of the medicines serviceable in such cases, the metallic tonics are most deserving of mention; especially the valerianate and sulphate of zinc, the nitrate and oxide of silver, and the sulphate of copper.

PARTIAL ANÆMIA.

273. We have the means of studying defect of blood in a part of the body in more diversified degrees than defect in the whole; and the result we find to be an impaired state of the functions in every degree, from that of mere weakness to that of total suspension and death. Thus temporary pressure on the chief artery of a limb soon causes numbness, weakness, and reduction of temperature. The same effects result in a more marked degree from the ligature of an artery in cases of aneurism, and are gradually removed as the supply of blood is restored through collateral arteries. In some such cases, the supply of blood is insufficient to maintain the vital properties of the part; then chemical affinities prevail (§ 50), decomposition ensues, and the part becomes gangrenous, and dies. A similar result ensues when the arteries of a limb become obstructed by ossification and coagulation, as in senile gangrene. This

event may be produced artificially in animals in forty-eight hours, by injecting charcoal powder into the artery of a limb, which totally obstructs its capillaries. (Magendie.) It is, most probably, by obstructing the circulation, and thus depriving the tissues of an element indispensable for the maintenance of their life, that inflammation and other lesions sometimes terminate in gangrene.

Softening and wasting of textures are also effects attributable to continued defective supply of blood. The former is exemplified in softening of the brain and of the heart in connection with ossified arteries; the latter in the wasting of parts subjected to continued pressure. Hence partial anæmia is concerned in producing many changes of structure arising under various circumstances. Deficient supply to secreting organs necessarily impairs the amount and quality of their secretions (§ 159).

SECTION II.

HYPERÆMIA, OR POLYÆMIA, EXCESS OF BLOOD.

274. *Too much blood in the system, or in a part*, is a most frequent element of disease. It implies an undue distension of the vessels which contain it; and a modification of the properties of these, and of the heart which propels it, is almost constantly a concomitant of this morbid condition. The chief vital properties of the heart and vessels are irritability and tonicity; excess (§§ 114, 121) and defect (§§ 116, 123) of these form most important elements, which modify the effects of excess of blood; and thus is suggested synthetically a division (long recognized as most valuable in practice) into active or sthenic, and passive or asthenic hyperæmia; which distinction is applicable to both the general and the partial excess of blood. Another variety of hyperæmia may be distinguished by an altered or perverted action of the vessels, which is chiefly applicable to the affection in a part, and includes that singular and complex condition, *inflammation*. A view of these important proximate elements of disease (§ 107) is given in the following table. It is not meant that the diseased conditions here specified are always separate, or that they consist merely of the elements here stated; but these are their most distinguishing parts, and most important in regard to treatment.

			Results.
Hyperæmia: Excess of blood.	General = Plethora	with motion increased = Sthenic	Hemorrhage.
		— — diminished = Asthenic	Flux.
	Local	with motion diminished = Congestion	Dropsy, &c.
		— — increased = Determination of blood	
		— — partly increased, partly diminished = Inflammation.	

SECTION III.

PLETHORA—GENERAL EXCESS OF BLOOD.

275. As general anæmia may arise from defective formation or excessive expenditure of blood, so general plethora may proceed either from too much blood being made, or from too little being expended. In either case, the blood accumulates and fills the heart and bloodvessels beyond the usual degree. But this implies a certain activity and health in the processes of digestion and assimilation, and also a freedom from any considerable local disorder. A person with weak digestion, rarely becomes plethoric; and one who suffers from a local ailment, is commonly warned by an aggravation of this, before the fulness can become general.

276. The persons who become plethoric are rather those overflowing with health, who have a good appetite, and indulge it, without sufficient regard to exercise and to the excernent functions; and whose digestive powers are in full activity. The blood-making process is ever on the increase, the vessels becoming more and more filled; and their fulness becomes manifest in the red face, distended veins, and full pulse; the heart is excited, and labors with its load, especially on exertion; hence palpitation and short breath may ensue, with somnolency and indisposition to exertion; but these may attract no farther notice than to induce the abandonment of exercise. The state of plethora, thus gradually induced, may be extreme, without any functions materially failing, and yet the subject is on the brink of various maladies. It is well if a great secreting organ is first excited under the high pressure, and relieves the system through a free discharge, as by mucous or bilious diarrhœa; or some unimportant and convenient set of bloodvessels may give way, as in epistaxis, or bleeding piles, &c.; or one of the great secreting organs may fail in its proper function (§§ 170, 254), as the liver or the kidneys; and a bilious attack, jaundice, or a fit of gout or gravel, is the consequence. Any of these, by establishing a perceptible ailment, disturbs the dangerous ease of the plethoric; and by rendering necessary a temporary discipline, saves him from the worst results of plethora—apoplexy, structural diseases of the heart, great vessels, lungs, kidneys, or liver.

277. Besides the causes already noticed, other circumstances may induce plethora. The diminution of a natural or habitual excretion or loss of blood, the drying up of a long-established sore or issue (§ 270), or the removal of a limb; all of which diminish the expenditure from the system, without impairing the blood-making process, often become causes of plethora, if no local disorder be excited before the vessels in general reach a plethoric tension.

278. The division of plethora into *sthenic* and *asthenic* arises from different proportions of the strength and irritability of the moving fibre,

which we have noticed as ultimate elements of disease (§§ 110 and 120, *et seq.*). Where the irritability and tone of the heart and arteries are in full amount, the increased quantity of blood excites these properties to full operation. Short of disease, the functions are active and energetic in proportion to the quantity of blood which their organs receive; the heart's action and the arterial pulse are strong and regular; secretions are abundant, sensibility is keen, contractility powerful and in good tone, animal heat is sustained, and the mental and bodily powers generally are great and active. But beyond this, plethora tends to disease; the heart's action is over excited; the pulse is frequent, as well as strong and hard; the face is florid and flushed, and the heat is almost feverish; the capillaries of secreting organs and surfaces are variously disordered; sometimes excited to excessive secretion, sometimes beyond it, to a state of fulness bordering on hemorrhage or inflammation; hence occur bilious attacks, hematemesis, lithic acid gravel, strong and acid urine, and various forms of sthenic gout; the sensibility and sensorial powers may be over-excited by the rapid flow, or oppressed by the pressure of the blood on the nervous centres. If the plethoric state is moderate enough to last for some time without immediate disaster, the nutritive function will eventually be affected. Some of the superfluous nourishment may become deposited in fat, which is another safety-valve to the plethoric; but even this throws an additional burden on the heart and bloodvessels, which are the more strained and oppressed, and are among the first of the textures to exhibit textural changes, in hypertrophy, valvular disease, aneurism, &c. Thus may originate structural disease, from the continued excitement of sthenic plethora.

279. Sthenic plethora is that which commonly affects the young, the active, and those of sanguine temperament (§ 41). It comprehends a rich state of the blood (§ 184), and an active condition of the nutrient function (§ 195). Its tendency is to cause general febrile excitement, active hemorrhages, fluxes, and inflammations.

280. In *asthenic* plethora, there is a want of contractility (§ 116) and tone (§ 123) in the moving fibre. The heart and other organs, instead of being excited by the augmented quantity of blood, are oppressed by its load. The pulse may be full, but it is slow; sometimes irregular or unequal. There is sometimes a tendency to faintness alternating with palpitation; physical examination shows the heart to be enlarged by the accumulation of its contents, which it cannot expel. The face is purple rather than red; the veins are generally distended; sometimes the extremities are apt to become cold. Other functions are sluggish, and imperfectly or irregularly carried on. The bowels are torpid, the urine scanty, high-colored, or turbid, sensibility is blunted, and the mental faculties dull, with lethargy or somnolency, the spirits often depressed, and the strength reduced.

281. Asthenic plethora affects especially those weakened by age, excesses, or previous disease, and those in whom the excreting organs act imperfectly; which imperfect action is a cause, as well as a consequence, of plethora. Asthenic plethora tends to produce congestions and passive hemorrhages, and fluxes and dropsies; and if continued, structural

changes in some organs, as dilatation of the heart, enlarged liver, varicose veins, &c. Congestion of the brain, with apoplexy or palsy, headache, or other symptoms of disturbed function, sometimes is produced; or if there be any organ, the vessels of which, from past or present causes (§§ 31, 32), are weak, this organ may be the first to suffer.

282. The symptoms of asthenic plethora hitherto described, are chiefly those of a depressed or oppressed state of the functions. Sometimes, however, there arise others, betokening excitement or reaction of an irregular kind. The pulse becomes quickened, and often irregular; the skin becomes hot or partially perspiring; sickness and vomiting may occur; the tongue becomes much furred, and sometimes brown and dry; the excretions are defective, unusually offensive, and often changed in appearance; the complexion becomes dusky, the eyes suffused, the mental faculties confused or impeded in low delirium or lethargy. This is a kind of congestive fever, described by Dr. Barlow as a result of reaction from asthenic plethora. It is possible that this description has been partly drawn from cases in which, besides asthenic plethora, some morbid poison (§ 258) has been in operation; but many of the symptoms here named may be fairly traced to a congestive fulness of the blood-vessels, with an impaired action of the excreting organs (§§ 70, 171, &c.); and consequently, with the diseased condition of the blood, which we have described to arise from imperfect excretion (§ 248, *et seq.*). The mere stagnation or imperfect motion of the blood will prevent it from undergoing properly the process of purification and elimination of its decaying materials, through the instrumentality of respiration and excretion; hence it becomes loaded with urea, lithic and lactic acids, and other effete materials, which unfit it for its proper uses, and irritate and disorder the organs through which it passes. The process of reaction or febrile excitement, which occurs in cases of asthenic plethora, is sometimes more distinctly connected with the condition of the blood, as in the case of gout (§ 254), rheumatism (§ 251), and various cutaneous diseases, which become developed generally in the atonic or asthenic forms.

[In thirty-one individuals suffering from well-marked plethora, the mean of the fibrine was 2.7, which is rather below the healthy standard. Plethoric persons are consequently not more liable to inflammatory diseases than others, and an appeal to clinical experience will sustain this assertion. The organic materials of the serum do not offer any remarkable alteration in proportion or composition in plethora. The blood of plethoric persons is very highly colored. On coagulation, the serum will be found more or less deeply tinged; the clot is larger, of moderate consistence, and contains a good deal of serum, and is never buffed. If the blood has flowed very rapidly from the vein, there is sometimes a thin, transparent pellicle on the surface.

In plethora, all the organic functions are more actively performed. There is a remarkable disposition to exaltation in the cerebral functions; the emotions are frequent and very mobile, without, however, those exaggerations and aberrations of sensibility, those nervous predominances, which almost constantly occur in anæmia. Plethoric persons are liable to certain accidents, as vertigo, dimness of vision, ringing in the ears,

and heats in the head. These symptoms have been usually attributed to cerebral congestion, a condition which has, however, never been ascertained. Andral thinks these phenomena sufficiently accounted for by the passage of an increased quantity of red corpuscles through the vessels of the brain. It is strange that, as we have seen (§ 264), opposite conditions of the red corpuscles as regards quantity, produce analogous phenomena. Plethora predisposes to hemorrhages. The bruit de soufflet never occurs in plethora, as has been erroneously stated.—C.]

283. *Remedial Measures.*—The means already described as useful in reducing an excess of red particles (§ 192) and fibrine (§ 214), are also applicable to the earlier and simpler states of plethora. In fact, in these states, the blood usually does exhibit this excess, for which bloodletting, and other evacuants, and abstinence, are the chief remedies. The propriety of bloodletting in extreme degrees of plethora, is evinced by the extent to which it may be carried without causing faintness. Thus Dr. M. Hall found that, from patients with congestive apoplexy, from forty to fifty ounces might be drawn without producing syncope; whilst, in the acute inflammations, the *tolerance* is usually less by about ten ounces. The beneficial effects of bloodletting are sometimes immediately manifest, although they are somewhat contrasted in the two varieties of the disease. In the *sthenic* kind the pulse becomes softer, weaker, and less frequent; in the *asthenic*, it often improves in strength and regularity, and sometimes rises to a natural frequency. In simple and recent cases of both kinds, a sufficient bloodletting, with due avoidance of the causes of the plethora (so far as that can be accomplished), and the continued use of a little aperient medicine, may complete the cure.

284. But if the plethora have lasted long enough to produce some of its ulterior effects (§ 282), bloodletting may be an insufficient, nay, in some instances, it may be an unfit remedy. In both kinds of plethora, medicines which increase the excretions are generally indicated, and the diet must be much restricted; but the particular mode in which these ends are to be accomplished, varies greatly in the two forms which I have been careful to distinguish.

285. In *sthenic* plethora, not only the blood is in excess, but also the irritability and tone of the moving fibre. Here, then, besides removing the excess of blood, sedative and relaxing remedies (§§ 115, 122), are indicated. Antimonials, salines, digitalis, and hydrocyanic acid, and a cool regimen, we have found to answer this purpose; and these are often most useful in the treatment of sthenic plethora. The same remedies, with mercury, colchicum, and some others, fulfil also another indication, which may be present, to augment excretions defective from an over-excited state of the capillary circulation, which borders on hemorrhage or inflammation. If any part should especially suffer, local bloodletting may be requisite to prevent such a result.

286. In *asthenic* plethora of some duration, on the other hand, although bloodletting relieves them, it does not restore lost tone to the over-distended vessels. Tonics (§ 124), and even stimulants (§ 119), may be necessary at the very time that blood is drawn; and there may

long be required such treatment as is calculated to restore the impaired functions of digestion and secretion, and to improve the depraved condition of the blood (§ 174). In such cases, the continued use of alterative aperients and diuretics, such as mild mercurials, with rhubarb, aloes, or senna, salines, and taraxacum, nitric acid, iodide of potassium, &c., may prepare the way for various tonics, such as columba, bark, and iron. In such cases, mineral waters, like those of Cheltenham, Leamington, and Llandrindod, are often of great service; first the saline, which are aperient and diuretic, and afterwards the chalybeate, which, although tonic, usually contain enough saline matter to keep the secretions free. Some of the latter class, as the Bath waters, sometimes excite torpid and plethoric habits to a critical reaction, by bringing on a regular fit of gout (§ 254).

The diet, which should be very spare in sthenic plethora, must not be too much reduced in that of the asthenic kind. The food should be simple, but nourishing, and adapted to the power of digestion. Stimulant drinks are not generally necessary; but previous habits must be considered, and not suddenly reversed. Regular out-door exercise, as much as the strength will bear without causing excitement or exhaustion, is a most salutary part of the regimen.

SECTION IV.

LOCAL HYPERÆMIA. EXCESS OF BLOOD IN A PART.

I. WITH MOTION DIMINISHED—CONGESTION.

287. The true nature and distinctive characters of *congestion*, or *local hyperæmia with retarded motion*, may be conveniently traced through its several causes, all of which agree in fulfilling the conditions here given as the definition of congestion, excess of blood in the vessels of a part, with diminished motion of that blood (§ 274). We have already found that parts of the vessels, and even the heart itself, become congested in asthenic plethora (§ 281); but this is as a part of a more general disease. We have now to consider the causes and phenomena of congestion of blood in a part, which may occur independently of general disease.

288. Bloodvessels become congested, or unduly distended with blood, when their proper elasticity and tone are overcome; and this may happen when an obstruction in the veins prevents the free escape of blood from them; or it may happen from weakness of the coats of the vessels themselves, which yield to the pressure of the blood transmitted to them. The chief causes of congestion may be classed under these two heads: 1. *Those of venous obstruction;* and, 2. *Those of atony of the vessels* (capillaries and veins). Under these two heads we shall notice various cases of congestion, which will explain and practically illustrate the subject. In congestion from either of these causes, it is obvious that, as the blood accumulates in the part, its motion diminishes;

for, as the great source of its movement is the force from the heart directed through the arteries, if the arteries remain unenlarged, the force which the enlarged capillaries and veins receive, will be reduced by being divided in their greater area.

289 (1). *Congestion from venous obstruction.*—When the arm is tied for venesection, the veins are compressed more than the arteries. Hence the veins swell, then the fingers become red, and, after a few minutes, purple, and the whole limb is swollen from the congestion of blood in its vessels. In like manner, cold applied to the surface of the body affects and contracts the veins more promptly than the arteries which lie deeper, and the capillaries speedily become congested, as evidenced by the purple color of the hands and face after exposure. Cold also impedes the circulation by increasing the adhesion of the fluid to the walls of the tubes, a mere physical operation, pointed out by Poisseuille. Congestions are caused in internal organs by an obstruction of the veins leading from them. Thus congestion of the brain may be produced by a tight cravat (§ 51), or by a tumor pressing on the jugular veins. Efforts of straining (§ 64), coughing, holding the breath, and asthmatic paroxysms, which impede the flow of blood through the lungs, cause congestions in various parts. Disease of the valves of the heart, which prevents the blood from passing onwards through it, produces fulness of the veins and of the capillaries in both the pulmonic and systemic circulation. Tubercles in the lungs cause congestion of these organs. Obstruction to the transit of blood through the liver causes congestion in the abdomen, hæmorrhoids, &c. The characteristic of congestion beginning with the veins is, that the veins as well as the capillaries are distended; this appearance is obvious during life in cases of aneurism or other tumor compressing the veins of the neck; and after death, in the full arborescent appearance of the veins in the congested part. Certain diseases of the organs of respiration, especially extensive emphysema of the lungs, in which the efforts of expiration predominate over those of inspiration, cause congestions, not merely by opposing the return of blood through the veins into the chest, but also by removing that suction influence which naturally much promotes the flow of blood in that direction at each inspiration. It has been pointed out by M. Berard (*Arch. Gén. de Méd.* Jan. 1830), and by Mr. A. Shaw (*Med. Gaz.* July, 1842), that the circulation in the liver is, in health, much dependent on this influence; and it may be inferred that the diminution of this influence by extensive vesicular emphysema will assist in explaining why hepatic congestion is so commonly combined with this pulmonary lesion.

290 (2). *Congestion from atony of the vessels.*—This comprehends a numerous class of cases. In some, the atony of the vessels (§ 123) affects the whole system, as in case of extreme debility, adynamic fevers, and the sinking which precedes death. The heart then acts feebly and without force sufficient to propel the blood through the whole circuit of vessels; these yield from want of tone, and most where they are least provided with tonic fibres; that is, in the capillaries and veins, especially of parenchymatous organs, which accordingly become congested. The

blood gravitates chiefly in parts that are lowest in the position of the body; which, in their weak state, yield to the accumulating blood. This occurrence of the congestion in *undermost* parts (*hypostatic*), is the distinctive character of that of weakened vessels. Thus the posterior parts of the lungs, intestines, and integuments, are found much congested.

291. In other cases, the weakness is local, without affecting the vessels generally, the weakening cause being applied to some vessels only. *Over-distension* is a common cause of congestive weakness of vessels. Thus from long continuance in one position, the lower vessels yield to the gravitating force (§ 51) of the blood, and become congested. This cause makes the feet swell after standing or walking long, especially in warm weather. A continued stooping posture, or lying with the head low, may occasion congestion of the brain, with headache, giddiness, confused vision, and may prove an exciting cause of apoplexy. Remaining long in a standing or sitting posture, often causes congestion in the hæmorrhoidal veins, liver, uterus, &c. Where the circulation is feeble, and the tone of the vessels weak (§ 123), these causes of congestion operate more readily and more permanently, than where the circulation is vigorous; yet these congestive affections, the result of weakness, are often mistaken for inflammations. Many of the pains and ailments of delicate females, are of this nature; and although temporarily relieved by depletory measures, are to be permanently counteracted only by tonic means (§ 124), which promote the vigor and equality of the circulation.

It must be borne in mind that congestion from mechanical causes, when it lasts long, may so weaken the vessels by over-distension, as to continue after their original cause has ceased to operate. Thus congestion of the brain or lungs, induced by a paroxysm of dyspnœa, or coughing, or by violent straining (§ 64), may not subside with the cessation of the effort; giddiness, headache, pain, dyspnœa, &c., remaining for some time.

292. In considering the operation of cold as a cause of disease, we found that it chiefly operates by constricting the vessels of the surface and extremities, and thus throwing the blood inwardly, causing internal congestions by *intropulsion* (§ 77). If this exists long, the tone of the internal vessels will be impaired, and the congestions will not cease on the restoration of warmth to the surface. Thus a permanent congestion in the lungs, liver, kidneys, mucous or serous membranes, whichever happens to be predisposed, may result; and this congestion may variously disorder the function of the part, or may lay the foundation for inflammation.

293. Malaria (§ 82), and the influences which produce continued and exanthematous fevers (§ 93), seem to have the same effect as external cold, but it is not so easy to explain how they operate. The cold stage of these diseases exhibits, in a high degree, the marks of intropulsive congestion; and it is well known that in ague, the congestive enlargements of the liver and spleen are among its most remarkable phenomena (§ 191). The congestions remaining during the febrile stages of fevers, seem to be the chief cause of their inflammatory complications.

294. Another cause of congestion is *over-excitement* of the vessels. It is well known that after a part has been inflamed, the vessels often remain dilated, but without the signs of inflammation. This is well seen in the conjunctiva, the throat, the skin, and in certain ulcers, and might be exemplified in some internal organs. The liver and stomach show many signs of congestion after the excitement of stimulant drinks (§ 56). But we may, under the microscope, trace the production of congestion apart from inflammation.

When a slight irritant, as a weak infusion of capsicum, is applied to the web of a frog, it first causes contraction of the vessels, especially the arteries (§ 120); then quickly follows enlargement of the arteries and other vessels with very rapid motion; after a while, the vessels gradually contract, and return to their natural size. But if the stimulant application be repeated several times, so as to prolong the determination of blood into the part, the vessels do not then uniformly contract. The arteries indeed shrink, but the capillaries and veins remain congested, and thus present completely the condition given in our definition, excess of blood with diminished motion (§ 287). This dilated state of the capillaries and veins must be chiefly ascribed to their losing tone after excitement (§ 123), more than the arteries; but the process which I have been describing, is accompanied by changes also within the vessels; numerous pale corpuscles adhere to the sides of the small vessels, and contribute to impede the current, and cause congestion by obstruction. Whenever the stimulus applied has been strong, this obstruction amounts to entire stagnation, and many vessels appear much enlarged, and filled with stagnant blood, or rather with an accumulation of red particles entangled in the coherent pale globules. For this reason, the vessels in which the blood is stagnant are of a deeper red than others, the red particles being arrested whilst the liquor sanguinis passes on.

295. All that has been now described belongs to congestion, and there can be little doubt that the intense and deep redness sometimes seen in congested parts, is partly made up of vessels in which the blood is absolutely stagnant. We shall find that a similar congestion and stagnation exist also in inflammation, and may be the only change left by it to be found after death, where the inflammation has not existed long enough to produce its more characteristic results. It is for this reason impossible to discern by anatomical characters between recent inflammation and some forms of congestion.

296. Congestion occurs in various organs and surfaces when their proper secretions are arrested, or suddenly diminished (§ 167). It is difficult to determine whether the congestion is the effect or the cause of the defective secretion in the first instance; and very probably the relation is mutual; at least, this is the most convenient view to take of the matter for practical purposes. Thus, means which increase the secretion (§ 172), will often remove the congestion; and those which relieve the congestion, generally restore the secretion. There is nothing inexplicable in this, even on the principles already laid down; for the free flow of a secretion will help to unload and set free the distended bloodvessels; and the means which free those vessels from their congested state, will

restore that freedom of circulation through them, which best ministers to the secreting process.

298. In the former edition of this work, I mentioned some cases of congestion which had not then been traced to any of the causes above specified, although it was not improbable that farther investigation would refer them to some of these causes. Thus, when the blood does not undergo its proper changes in the lungs (§ 234), its passage through these organs is partially impeded, and it accumulates in the right side of the heart, and in the venous system generally. Congestions thus form a prominent part of the pathology of asphyxia. From the observations of Dr. John Reid, it appears that some obstruction also occurs to the passage of the blood through the systemic capillaries, as proved by the increased pressure in the arteries, indicated by the hæmadynamometer.

I stated that it remained for future observers to determine whether these obstructions are connected with contraction of the vessels (§ 120), increased spissitude or cohesion of the blood, or other simply physical cause; or whether they depend on peculiar (vital) attractions and repulsions exerted between the vessels and its blood, which properties are supposed by some physiologists to constitute an important element in the healthy, as in the morbid phenomena of the capillary circulation.[1]

[1] Whatever influence the vital properties of the blood may be supposed to exert in impeding the passage of the blood through the capillaries, I can see no reason for admitting that they in any degree contribute to its motion. That the power of the heart, distributed by the arteries, is sufficient to carry on the circulation, is apparent from several experiments, of which some performed by my colleague, Dr. Sharpey, are the most convincing. A syringe, with a hæmadynamometer to show the amount of pressure used, was adapted to the thoracic portion of the aorta of a dog just killed, which vessel had been previously tied immediately above the renal arteries, and the vena cava inferior was opened at its exit from the diaphragm. Fresh bullock's blood (deprived of its fibrine by whipping and straining, to prevent its coagulation) was then injected with a pressure of three and a half inches of mercury, *and passed out of the vein in a free stream, after having pervaded the double capillary system of the intestines and liver.* When the pressure was increased to five inches mercury, the blood spirted from the vein in a full jet. When the aorta was not tied above the renal arteries, but left free, the same pressure was sufficient to drive the blood through the extensive ramifications of the lower extremities. On the same instrument being adapted to the pulmonary artery, it was found that a pressure of from one and a half to two inches of mercury was sufficient to propel the blood through the capillaries of the lungs, so as to flow freely from the left auricle or pulmonary veins.

The amount of force thus used is not greater than that which the hæmadynamometer shows the heart commonly to exert in propelling the blood during life, in the systemic and pulmonary circulation respectively; and we thus obtain almost a demonstration, that the heart's power, distributed by the arteries, is sufficient for the process of the circulation. An intelligent reviewer of the former edition of this work, has opposed to this inference the case of a fœtus without a heart, in which circulation and nutrition seem to have been well performed; but before we can admit the force of such a questionable and exceptional fact, it must be proved that there was no compensatory muscular apparatus in the large vessels, such as is known to exist and aid the circulation in fishes and insects, to the structure of which these monstrosities often in other respects approximate.

The chief arguments for and against the existence of vital properties of attraction and repulsion at sensible distances, have been well stated by Professor Allen Thomson, in the article "Circulation," in the *Cyclopædia of Anatomy*, to which I would particularly refer the student. In addition to these, I would state that in many long and careful microscopic examinations of the circulation in the frog's web, variously modified by different agents, I have never witnessed any movement of the blood-particles, which was not plainly referable to the action of the heart or of vessels. The share which the arteries have in regulating the flow of blood, through the capillaries and veins, is most evident. When the arteries increase in size, the flow becomes very rapid and general; when they diminish, the flow is tardy, and even ceases in some capillaries; and when the arteries contract, so

The researches of my friend, Mr. John Erichsen, (*Edin. Med. and Surg. Journ.* No. 163), on asphyxia, have satisfactorily settled this question in favor of the first of these alternatives, which was long since suggested by me (*Med. Gaz.* Sept. 1835 and 1838). After having shown that analogy is not opposed to the fact of the contraction of the minute arteries being excited by the passage of venous blood through them, Mr. Erichsen adds:—

"But we may go a step farther, and prove that it (venous blood) actually possesses this power; causing these vessels to contract distinctly, as I have several times observed, on examining, under the microscope, the mesentery of rabbits, during and immediately after the process of asphyxia. This may be done without much difficulty, as the circulation of these animals, when quite young, continues for many minutes after the struggles of asphyxia have ceased. On asphyxiating a young rabbit, a portion of whose mesentery had been conveniently fixed under a powerful microscope, the following phenomena will be observed to ensue. For about a minute after the struggles of the animal have ceased, the circulation appears to be going on with its usual rapidity; it then gradually becomes somewhat slower, the arteries contracting in size, containing less blood, and assuming a lighter and more tawny color than before; whilst the veins become congested, and evidently fuller, assuming, when viewed by transmitted light, a very beautiful crimson hue. As the circulation becomes more languid, the arteries continue contracting, and acquire a lighter color; the diminution in their size, and the difference in the quantity of blood contained in them and in the

as to permit no blood to pass through them, the blood which still fills the capillaries and veins becomes quite stagnant, without a sign of spontaneous movement. When motion begins again, it may always be traced to an artery, which first admits a file of single globules, which come few and far between, and in pulses; afterwards, as the artery enlarges, many rush in a continuous rapid stream, supplying proportionate motion to the vessels beyond. These observations precisely correspond with those since made by Mr. Erichsen, and numerous recent microscopic observers. In the recent work of Mr. Travers, on Inflammation, some terms are applied which might seem descriptive of spontaneous motion of the blood-corpuscles, such as "pioneering corpuscles," but it is plain that this term is used figuratively, for Mr. Travers distinctly traces the motion to the impulse of the heart, communicated to the adjoining capillaries.

Many of the instances of supposed vital motions in the blood, and other organic molecules, are referable to mere physical causes. Similar movements may be seen, quite as animated in appearance, on mixing, under the microscope, two drops of saline solutions of different strength or nature; any insoluble powder in these drops moves, as it were, spontaneously, and the motion continues until these drops have entirely pervaded each other. Still more lively motions are seen on adding any resinous tincture to water. Similar causes operate on blood-molecules, giving them motions which appear to be spontaneous. But blood-particles move also from another cause; they are not only carried by the current, but they are often changed in shape by it. Being vesicles, they swell or shrink by endosmose and exosmose, on any change in the density of the liquid in which they are conveyed; and these changes affect their position and form, their aggregation and separation, in a manner which might readily give the idea of their possessing spontaneous motions.

Although it seems unwarrantable to admit a self-motory power in the blood-particles as *aiding* in the circulation, it is highly probable that changes in them, as well as in the vessels which convey them, may *impede* the circulation. The adhesion of the lymph-globules to the sides of the vessels, and to each other, and perhaps, the cohesion of the blood-disks, are changes likely to produce this effect. We shall find these have a large share in causing the obstruction of inflammation; and, as before mentioned, they probably operate in intense and long-continued congestion; but Mr. Erichsen's observation disproves their operation in asphyxia.

veins, being most marked. The motion of the blood in the capillaries now becomes oscillatory, the whole mass of blood being, at each impulse from the heart, slowly propelled forward, and then moving backwards. This to and fro motion continues for some time, and then ceases entirely. On restoring the heart's action by setting up artificial respiration, an impulse was evidently transmitted from the blood in the arteries to that in the capillaries in a pulsatory and jerking manner, which was soon communicated to the veins, driving forward the whole mass of globules accumulated in them, and gradually becoming more equable and powerful until the circulation was completely restored. I have watched these phenomena most attentively in the mesenteries of young rabbits, and have never observed anything like spontaneous movements in the capillaries; the blood contained in which was invariably most clearly and distinctly influenced, solely by the impulses it received from that contained in the arteries. Nor have I ever been able to discover any obstruction in the vessels in consequence of the adhesion of colorless globules to the sides—a phenomenon that I especially watched for, and which has by several been supposed to occur. The diminution in the diameter of the smaller arteries, and the proportionate difference between them and the neighboring veins, were most evident, and were such as could leave no doubt in my mind, as to the important part that the contraction of these vessels plays, in giving rise to an obstruction to the passage of the blood through them in asphyxia; in which I have no doubt that it is the principal, if not the sole agent.

These observations correspond perfectly with what I have many times observed in the frog's web; and we may fairly infer that the same obstruction which operates in the systemic circulation, will suffice also in the pulmonary. The notion of vital attractions of the blood for the vessels, or even of the aggregation of the red corpuscles (suggested by an imperfect observation of Mr. Wharton Jones), as causing the obstructed circulation of asphyxia, is not only superfluous, but untenable; for, were the obstruction in the capillaries and veins, the arteries, for a time at least, should exhibit distension, which the above description proves not to be the case.

The instances of obstructed pulmonary circulation recorded in Mr. Blake's experiments, in which certain saline solutions (of salts of soda, silver, &c.), injected into the veins, caused death, by obstructing the passage of blood, without coagulating it or arresting the breath, will admit of the same explanation

299. We have considered atony of the small vessels (§ 290) as a chief cause of congestion; and it is so, not only by making them yield and become distended by the accumulation of blood, but also by rendering them unfit to transmit the force of the current in its proper direction. Vessels which have lost their tone, become inelastic and tortuous, and the very accumulation of blood in them opposes an increasing obstacle to its passage through them. The physical principle to which I now refer is not generally understood, and I will illustrate it by some experiments.

300. To one of Read's enema syringes, was adapted a tube with two arms; to one arm was fitted a brass tube two feet long, having several

right angles in its course; to the other arm was tied a portion of rabbit's intestine, four feet long, and of caliber (when distended with water) double that of the brass tube. The intestine was placed in curves and coils, avoiding angles and crossings, which might obliterate the canal. The discharging end of both tubes was raised to the same height, that of the intestine being kept open by a short tube of metal. The tubes were then both filled by successive strokes of the piston; and when they both began to discharge, the quantity received from each in a given number of strokes was ascertained. Without giving the details, it may be stated that the small metal tube discharged from two to five times the quantity discharged by the larger but membranous tube; the difference being greatest when the strokes of the piston were most forcible and sudden, by which the intestine, although much swelled at its syringe end at each stroke, conveyed comparatively little water. The difference was farther increased by raising the discharging ends higher; and when both ends were raised to the height of eight or ten inches, the gut ceased to discharge, each stroke only moving the column of water in it, but this subsiding again without rising high enough to overflow. On increasing the force of the stroke, the part of the intestine nearest to the syringe burst.

The experiment was repeated in various ways, of which I will mention one, with a metal tube two feet eight inches long, and a bore three-eighths of an inch, and a portion of dog's intestine of the same length, but when distended, of double the diameter. The metal tube yielded three times more liquid than the intestine.

301. These experiments show that flaccidity and increased length and size of the tube afford impediments to the passage of liquid through it; and although the experiments exaggerate the difference between healthy and relaxed or congested vessels, yet they really prove that the increased tortuosity and number of vessels in a congested part, the greater mass of their contents, and the atonic flaccidity of their coats, do truly form additional obstacles to the passage of the blood through them, although the amount of these obstacles will vary according to the state of the connected circulation.

These experiments illustrate a principle that is too little considered in animal and general physics; the *loss* or *neutralization* of *force*, *by misdirection*. The bloodvessels, in their healthy condition, are so constituted as to make the most of the heart's propulsive power, and transfer it throughout their whole length; but when dilated, tortuous, flaccid, and otherwise altered, they misdirect and exhaust it (as in the experiment with the intestine): it is partly expended in distending and dilating the nearer portion, whilst a sufficiency does not remain for the onward propulsion of the blood, which therefore stagnates and accumulates in the congested vessels. We shall have other occasions to revert to this principle, which explains many anomalies of unequal circulation. It is probably much concerned in keeping up the congestion which has been for some time established by other causes; and it may be the means of perverting an increased flow through the arteries, which otherwise might sweep away the congested blood—into that mixture of opposing forces, which exists in inflammation. This conversion of congestion into

inflammation frequently occurs in circumstances corresponding with this description.

THE SYMPTOMS AND EFFECTS OF CONGESTION.

1. *Effects in the congested part.*

303. When the arm is tied for venesection, the parts beyond the ligature become congested. At first, the hand feels rather warmer than usual, and somewhat tender, from the distension of its vessels with warm blood; but it soon becomes numb, cold, and weak, showing that the want of circulation lowers its vital properties. In like manner, simple congestion generally impairs the vital properties of internal organs, although the undue distension of their textures by the increased mass of blood, may cause partial excitement. Natural contractility and sensibility are lowered, whilst pain (§ 126), spasm (§ 114), and morbid sympathies (§ 149), are often produced, but in a manner much less distinct and constant than in inflammation or determination of blood. Thus congestion of the liver is sometimes accompanied by pain or tenderness; sometimes it is without either. Congestion of the stomach sometimes causes gastralgia, nausea, and vomiting, and altered appetite; but these symptoms are often absent when the amount of disease of the liver or heart and the subsequent occurrence of hæmatemesis, leave no doubt that the stomach was congested. The same remark is applicable to the kidneys, the uterus, the brain, and other organs. We often see the tonsils and uvula congested and enlarged, without pain or soreness. Impaired nervous and muscular function is a more constant concomitant than pain, or any symptom of irritation.

304. The natural secretions of congested parts are sometimes at first augmented, as in congestion of the conjunctiva and Schneiderian membrane from cold; but more generally they are diminished, as in bronchial congestion (dry catarrh), and congestion of the liver, kidneys, &c. But very commonly, congestion leads to an increased transudation from the whole distended capillaries, causing effusions of the watery and saline part of the blood, more or less impregnated with albumen, and sometimes even with fibrine, as exemplified in the fluids of fluxes and dropsies.

The process by which this is the effect of congestion or secretion, seems to be chiefly a physical one. The portions of the vascular apparatus most concerned in supplying the secreting structure, seem to be the middle parts of the capillaries, which are often so turned or convoluted, as to receive the most direct force of the current from the arteries. But when congested, the vessels leading to the middle capillaries become yielding, loose, and tortuous, and the force is much expended in dilating these before it can reach the portions which supply the secreting surface, or cells;[1] these portions are in the condition of the distant end of the

[1] It may seem that this is taking too mechanical a view of the process of secretion; but be it remembered that I do not ascribe secretion wholly to mechanical agency, but only assert what is known to be a fact, that due force of the capillary circulation is a condition favorable to this process. In lately inspecting the beautifully injected preparations of Mr.

intestine in the experiment above related (§ 300), not duly receiving the force of the current. Thus the more essential effect of congestion is to impair the natural secretion.

305. But the distension of the congested capillaries sometimes leads to a general exhalation of their more watery contents, which, mingling with the natural secretion, render it watery and sometimes albuminous. Thus congestion of the bronchi sometimes ends with bronchorrhœa. Congestion of the intestines causes diarrhœa; congestion of the uterus, leucorrhœa; congestion of the kidneys, watery and sometimes albuminous urine; congestion of the lungs and pleura, hydrothorax; of the heart, hydropericardium; of the abdomen, ascites, &c.

306. The element of congestion chiefly concerned in the production of these effusions, is extreme distension of the vessels. They are less commonly found, therefore, in mere hypostatic or gravitative congestions (§ 291), in which the distension is inconsiderable, but they more result from congestions from venous obstruction (§ 289), especially when these occur suddenly, whilst the vigor of the circulation is not impaired. Thus the congestions connected with diseased heart or liver, produced by acute attacks or other additional causes of obstruction, especially in plethoric subjects, if not soon removed, are pretty sure to end with dropsy, flux, hemorrhage, or inflammation. The circumstances that determine which of these results shall ensue, will be considered when we come to these proximate elements of disease; but it may be mentioned that besides distension of the vessels, the condition of the blood considerably influences the result; a watery state promoting the transudation (§ 222), whilst a highly albuminous and fibrinous blood (§ 195) requires more pressure to make its watery parts pass through the coats of the congested vessels.

307. The same circumstances determine the character of the effused fluid. Where the blood is poor, the watery parts easily pass from congested vessels, even without much distension, and contain but little albumen. But if the blood abounds in the proteine compounds, more pressure is required before much effusion takes place; and then, when the pressure is great, the fluid effused often contains, not only albumen in large proportion, but self-coagulating fibrine also (§ 211). Thus, I have seen the fluid of the pleura and pericardium, in rapidly fatal obstructive mitral disease, coagulate spontaneously into a fibrinous crassamentum, when removed from the dead body. The gelatinous masses of lymph often found in the peritoneal sac of the abdomen and pelvis in ascites from contracted liver, I have no hesitation in referring to the same origin.[1]

308. Fluxes arising from congestion of high tension exhibit an unusual amount of animal matter of an albuminous or mucous kind, as

Dalrymple, and Mr. Toynbee, I was particularly struck with the distribution of the capillaries of secreting surfaces, such as mucous and synovial membranes. These capillaries run pretty straight from the minute arteries, and end in loops and ampullæ on the surface, the returning vessels passing back as straightly. The physical effect of this provision is obviously to direct the chief force on the terminal loops which supply the secreting surface.

[1] This is the true pathology of the "fibrinous dropsies" of Vogel and other German writers.

instanced in bronchorrhœa, mucous diarrhœa, and leucorrhœa. I have been induced to suppose that the polypous concretions and pseudo-membranous films occasionally effused on mucous surfaces, may result from long-continued congestion, with a highly fibrinous state of the blood (§ 195). I have seen these evacuated from the air-tubes, in one case, and in several others from the intestines, from time to time, for months, and even years, without symptoms of inflammation, but under circumstances rendering it probable that congestion was present. Extensive disease of the heart existed in the former case, and disease of the liver or amenorrhœa in the latter.

309. I have, for several years, referred albuminous urine (§ 249) to congestion of the kidney; and this view has been lately confirmed by some experiments by Mr. G. Robinson. The following considerations led me to entertain this opinion: 1. The urine often becomes albuminous, during great embarrassment of the circulation in cases of organic disease of the heart or lungs (§ 289), when the kidneys are otherwise healthy. 2. I have in many instances, observed temporary albuminuria during the cold stage of ague, and the congestive stage of eruptive fevers. 3. In granular degeneration of the kidney, the amount of albumen in the urine is augmented by circumstances causing congestion of the kidney, and is reduced by remedies suited to remove this. 4. The most common form of Bright's disease of the kidney in its earliest stage, presents the appearance of a highly congested structure, and is excited by causes calculated to produce congestion, such as frequent irritation of the kidneys by stimulating liquors—congestion from exhausted tone (§ 294); continued exposure to cold, especially after the kidneys have been thus excited—congestion from intropulsion (§ 292); scarlatina probably operates as the two last combined. 5. The albumen in the urine abounds most in the congestive (first) stage of Bright's disease—the vessels becoming more or less obstructed in the progress of the disease, by deposit of fibrine with granular cells in the tubules, and in some instances around them, which deposit, at the same time, perpetuates some degree of congestion, whilst it supersedes the proper secreting structure.[1]

[1] The secreting structure is partly diminished in another way also. The granular deposit presses not only on the bloodvessels, but on the uriniferous tubuli also; and wherever it totally obstructs them, their office ceases. These tubuli becoming distended, form the serous cysts, so commonly found in granular kidneys, and sometimes in those which are not granular. But these cysts contain serum, or a gelatinous fluid, with little or no urine; and this fact has been urged against the notion that they are dilated uriniferous tubes. The explanation, however, is not difficult. The secreting function of the kidney lies in nucleated cells lining the tubuli (Bowman); growing, filling, and bursting, as these cells do, by imbibition from adjoining vessels, this process, which is that of secretion, must be stopped when the cells are themselves pressed on by an accumulation of their own secretion which cannot escape; but serous exhalation from the bloodvessels still goes on, displacing by endosmosis the urine, and at last distending the duct into a cyst. The same explanation will apply to the serous cysts of the liver. This view explains how retention of urine or bile, may lead to the suppression of the secreting power.

The above note, which appeared in the first edition, represents the view which still appears to me the true one of the origin of cysts in the kidney, and it corresponds with the opinion advanced during the present year by Dr. George Johnson, in a paper read to the Medico-Chirurgical Society. At the same meeting, a communication from Mr. Simon represented the cysts as enlarged epithelial cells, developed in consequence of the obliteration of many of the tubes.

310. From what has just been stated, it may be inferred that congestion, if continued, may affect the nutrition and structure of textures. It generally tends to cause an increased deposit in them, constituting a variety of *hypertrophy*, or overflow of plastic matter. Thus, with diseases of the heart which cause congestion, there is an increase in the weight of viscera generally, more particularly of the lungs and liver. (Clendinning.) The enlargement of the liver and the spleen from long attacks of intermittent fever (called ague-cake), may probably be referred to the congestion which this disease is known to induce (§ 293). I have known a similar enlargement of these organs to ensue, after long-continued exposure to cold and damp (§§ 77, 292).

311. But the hypertrophy resulting from congestion is probably not of a uniform kind, comprising equal growth of all the textures; but, arising from an effusion of lymph from the most congested vessels, it is an intervascular deposit—at first mottling and exaggerating the appearance of the natural structure, as seen in the nutmeg liver and in the early soft stage of granular degeneration of the kidney—afterwards contracting and compressing the natural structure, and ultimately causing its condensation and atrophy, whilst the new deposit itself forms a granular or nodulated texture of low vitality (§ 211).

312. Such I believe to be the nature and origin of some varieties of cirrhosis of the liver, and granular degeneration of the kidney. The variations which these structural diseases present, may often be traced to their degree of advancement, or to the extent to which they involve the structures; and an argument in favor of their origin in congestion, may be found in the fact that they are commonly more advanced and extensive in the most dependent parts of the organs, and the lower margins of the liver, where congestion is most promoted (§ 290). It is highly probable, also, that these plastic products of congestion are, in some cases, more or less developed and farther modified by determination of blood or inflammation, and by the composition of the blood itself.

Thus, in some instances, the deposit exhibits more of a fibrous or closely compacted granular character, firmly adherent to the investing membrane, which is more the character of an inflammatory product. In others the deposit is loosely granular, or in irregular cells, often with a predominance of fat-globules, with little cohesion; indicative of a degenerative condition of the plasma, such as is found in scrofulous or cachectic states.

Long-continued congestion in the lungs may cause hypertrophy of the intervesicular and interlobular texture, and in some cases, partial consolidation of the vesicular structure itself. Such changes are frequently met with in connection with long standing disease of the heart, and abound most in the posterior parts of the lungs, and near their roots, the most vascular parts. In the membranes of the brain, and in the capsules of the heart, liver, and spleen, opaque thickening is often seen along the course of the bloodvessels, especially of the veins; apparently the result of the overflow of nutritive matter from these vessels.

2. *Effects of local Congestion on the System.*

When a congestion is extensive, it has constitutional as well as local effects. In proportion as blood accumulates in excess in a part, it leaves the rest of the body with less than its proper share, and the limbs and surface generally may show various symptoms of weak circulation and want of blood. Thus, with considerable congestion of the liver, lungs, or brain, the surface is pallid and chilly, the pulse weak and small, the extremities cold, there is a peculiar feeling of languor or weariness, and all the functions are indifferently performed. Such an effect on the system may be produced artificially, by applying a tight bandage around both thighs at once, or even both arms in a weak person; the limbs beyond the ligature become congested (§ 289), leaving a deficiency of blood in the rest of the body. The extreme of this condition is the cold fit of an ague, in which extensive internal congestions are the most essential pathological change (§ 293). As in this example, so with other extensive congestions, more especially if suddenly induced, as by cold (§ 294), a reaction may ensue (§ 16), causing quickened pulse and circulation, hot skin, and other phenomena of fever. Where this reaction is vigorous, it may fulfil its object in sweeping back the congested blood into the circulation, and thus restoring the balance. Where the reaction is weak, it will fail to remove the congestion, but constitutes a low feverish excitement, often remittent in type, with depraved functions, foul tongue, impaired excretions, restless nights, &c., which may proceed for an indefinite period, until a critical evacuation by sweat, urine, or diarrhœa (§ 171) terminates it, and with it sometimes the congestion that has induced it. In other cases there is no symptom of reaction; but the congestion, if extensive, is not without its injurious constitutional effects; the stagnant blood, unpurified and unrenovated, becomes gradually injured in its composition; and not only unfit for farther use in the economy, but a source of contamination to the rest of the blood (§ 191), and a cause of cachexia in the system at large. Extreme results of this kind are presented in the slow operation of malaria in those continually exposed to their influence (§ 85), in the low apyrexial congestions which precede typhoid pneumonia; but slighter and commoner examples are frequently observed in those whose general health suffers from continued congestion, and in whom the loaded and vitiated excretions, which, even without fever, continue to be thrown off, afford evidence of a process of decay in the animal fluids, which is the necessary consequence of their imperfect purification.

REMEDIES FOR CONGESTION.

313. The most important means in the removal of congestion are those which contribute to the removal of their causes. Thus the loosening of a ligature, or the reduction of a tumor, compressing veins; the moderating the inordinate and inefficient action of a diseased heart; the restoration of the secretion of the liver (§ 172), will severally tend

to diminish the congestions resulting from these different causes of venous obstruction.

314. So, also, in the treatment of congestion from atony or weakness of the capillaries, it is important to remove the circumstances which have caused this atony. In many cases it is over-distension from gravitation (§ 296); here change of posture gives relief. Thus, in congestive fevers, and other states of continued weakness, it is useful to change from time to time the position of the patient from supine to prone, or lying on either side. With congestion of the head, this part should be supported high. The recumbent posture gives much relief to congested hæmorrhoidal or uterine vessels; as we see it reduce the swelling of varicose limbs.

Pressure is sometimes a remedy for congestion, by supporting the weak vessels, and promoting their contraction. This forms a chief part of the useful operation of bandages, adhesive plasters. and even of poultices, in various external congestions. It probably might be more extensively applied to these, and even to some internal congestions, in the modes suggested by Dr. Arnott, by mercury, or by the soft slack air-cushion pad.

Friction is a modification of pressure especially suitable to some forms of congestion, being calculated to give the motion that is defective, as well as to support the weak vessels. It is obviously useful in external congestions from cold; and sometimes in visceral congestions, as those of the liver and abdomen generally. Exercise operates somewhat in the same way.

315. Another class of remedies for congestion comprehends those which promote the contraction of the dilated vessels by augmenting their contractility or tone (§ 124). In this way, astringents and cold operate; as in the use of solutions of alum, sulphates of zinc or copper, acetates of zinc or lead, and infusion or decoction of oak bark, catechu, kino, nutgalls, &c., in various congestions, particularly of the conjunctiva, throat, rectum, and vagina. The most obvious part of the action of bark, quinia, and arsenic, in the cure of ague, is in their reducing the great visceral congestions, which form their most remarkable, and perhaps their most important, pathological element.

316. The utility of astringents in congestion is limited by the fact, visible under the microscope, that they commonly contract the arteries more in proportion than the capillaries and veins, which are most distended. Hence they may still farther impair the motion of the blood, and increase the congestion. A reaction, however, sometimes occurs, which converts the operation of the astringent into that of a stimulant, which is another kind of remedy for congestion. The same remark is applicable to cold; and even more so, inasmuch as it also causes a physical obstruction to the flow of blood, in the manner formerly described (§ 296).

Stimulants sometimes are remarkably effectual in removing congestions. Thus diluted spirit lotion to a congested conjunctiva, capsicum gargle to a congested throat, a stimulating wash or ointment to a purple sore or surface, will often signally reduce the congestion. Other congestions are removed by exciting the circulation generally; a stimu-

lant draught, or even one of any hot liquid, relieves the pulmonary congestion which has induced a fit of asthma; a congestive headache is sometimes mitigated by similar means. Well-regulated exercise tends to disperse congestions in various parts. Various agents, which specifically excite particular organs or parts (§ 173), are often useful in removing congestions from them. Thus mercury is, in some cases, a remedy for a congested liver; some diuretics, as digitalis and cantharides, for congested kidneys; squill, benzoin, and other expectorants, for bronchial congestion.

317. The influence of stimulants on congestion may be illustrated by the microscope. A solution of capsicum applied to a frog's web, congested after previous irritation, causes an enlargement of the arteries, and an increased flow of blood to and through the congested vessels. This flow restores motion where it was deficient, sweeps away the accumulated blood, and, in some instances, causes the vessels to contract afterwards to their natural size; so that the congestion is completely removed; in that case, the cure is complete. In other instances, however, the stimulants fail to clear the congested vessels; the enlarged arteries pour in more blood; but this, not overcoming the obstruction, increases the hyperæmia, and, as we shall afterwards see, may convert it into inflammation. Thus it appears that stimulants, as well as astringents, although occasionally proving remedies for congestion, sometimes tend to increase it; and this they are most likely to do when the congestion is extensive, or of long continuance, or when its causes are still in operation.

318. Under such circumstances, congestion is better relieved by another class of remedies, depletion, and various evacuants. Bloodletting by puncture or incision in the congested parts, enables the distended vessels to unload themselves, and they may recover their size; and the utility of this expedient is shown in scarifications of congested conjunctiva and tonsils, and leeches to a congested os uteri. But the blood is more usually drawn from the vicinity of the congested part, as by cupping, or leeches on the chest or side for congested lungs or liver;[1] to the sacrum for congested uterus; or leeches to the anus for congested intestines. Or, without actually shedding the blood, it may be drawn away from the congested part by derivation, that is, by agents, which cause determination of blood or congestion in other parts; as dry cupping, mustard poultices, and other stimulating applications to the surface, and by purgatives and other evacuants from the interior. A still more powerful agency of the class of derivants is that of removing atmospheric pressure from a limb by inclosing it in an air-tight vessel, and partially exhausting the air. This was invented by Dr. Arnott, and has been lately employed by Sir James Murray and several French practitioners.

These act by inducing determination of blood, or even inflammation

[1] It is remarkable how quickly congestions may be reduced by these means. I have known a congested liver, which reached from the umbilicus to the fourth right rib (as traced by percussion), reduced in twelve hours to its normal dimensions by cupping and free purging. Piorry describes a still more speedy reduction of the liver in ague, by the influence of the sulphate of quinia.

in another part, and thereby *drawing* away blood from the congested parts. Some means, however, may be employed, which prevent or remove congestion by damming up the blood in other parts, and thus inducing a *counter-congestion.* It has long been practised with success, to stop a fit of ague by applying a tourniquet to the thigh; and Dr. Buckler, of Baltimore, following a popular practice of a similar kind, has called the attention of the profession to the general utility of the remedial measures which he terms *hæmotase;* which consists in the temporary application of ligatures to one or more limbs, which are thereby so much congested, that there is not blood left in the circulation sufficient to supply the congested vessels, and these, relieved of pressure, may contract and expel the accumulated blood. I have employed this plan in several cases in which temporary congestions were produced in the lungs and liver, and sometimes with a very remarkable preventive effect; but it has little influence on congestions which have long been formed, and acts chiefly on the distribution of blood in the larger bloodvessels.

319. The operation of several of the foregoing agents, in combination or succession, is generally more effectual than that of single ones in the cure of congestions. Thus congestion of the liver may resist the action of mercury, and may even be aggravated by it (§ 204), until the vascular distension has been partially reduced by local bloodletting or derivants; then the mercury, by increasing the secretion, reduces the remaining congestion. Congestion of the kidneys is augmented rather than diminished by diuretics, which then fail to increase the secretion of urine, but may only render it more albuminous (§ 304). But after some relief has been given by cupping to the loins, and hydragogue purgatives and diaphoretics, then some diuretics, particularly digitalis and cantharides, cause a freer flow of urine with less albumen. The same point might be farther exemplified; but it is unnecessary to multiply instances.

320. The cause of congestion being, in many instances, atony of the vessels (§ 290), it may often be counteracted by circumstances which augment the tone of the vessels, locally or generally. Thus cold, astringent, or, occasionally, stimulant applications, by bracing the fibres and invigorating the circulation in a part (§ 124), render it less liable to congestion from disease; and general tonic measures operate in a similar way on the whole system. The efficacy of bark and arsenic in preventing, as well as in removing the internal congestions of ague, probably depends on their power of augmenting the tone of the vessels, of these parts (§ 315), so that they no longer yield to the distensive accumulation of blood within them. A similar virtue seems to be possessed, in some degree, by iodine and its preparations, especially the iodide of potassium; under the use of which the disposition to local congestions is diminished, and those formed are sometimes dispersed, as exemplified by the external use of iodine in lepra and other congestions of the skin, and of iodide of potassium in congestive headache. Mineral acids and other tonics have a like effect in cases of general weakness. The treatment calculated to remove the results of congestion will be considered under the subjects, HEMORRHAGE, FLUX, DROPSY, and INFLAMMATION.

SECTION V.

LOCAL HYPERÆMIA.—EXCESS OF BLOOD IN A PART.

II. WITH MOTION INCREASED—DETERMINATION OF BLOOD.

321. Numerous examples of this kind of active hyperæmia are presented in health as well as in disease. The face and neck in blushing, the uterus and breasts at the periods of gestation and lactation, the gums during the process of dentition, the antlers of the stag at the season of their development, furnish instances of local determination of blood occurring in health. The increased number and size of the blood-vessels, manifest by the vascular redness in these cases, show the increased quantity of blood in the part; and the stronger pulsation of the arteries leading to the part indicates the augmented motion of that blood (§ 274).

322. In disease, we meet with many examples. Determination to the head is one familiarly known; and it affords the opportunity of displaying one of the characteristics of determination, in the enlargement and throbbing of the carotid arteries. I have witnessed this phenomenon in a great variety of cases. One patient was subject to attacks of determination of blood, which caused him so much suffering and loss of moral control, that he cut his throat to destroy his life. When recovering from the wound, attacks sometimes came on; first, with beating of the carotids, then flushing of the face and head, suffusion of the eyes, and sensations of distraction in the head. In the slighter attacks, these symptoms would all pass away in a minute or two. I have, in several cases, observed the same symptoms usher in the paroxysms of mania. Fits of epilepsy and convulsive hysteria are immediately preceded by throbbing of the carotids, which shows that determination of blood is the proximate cause of the paroxysm. Drs. Darwin and Parry relate cases in which convulsive fits were prevented by pressure on one of the carotids; and I have practised this expedient with success in several instances. Many of the epileptic patients whom I have questioned have stated that the fit is always preceded by palpitation, which, for reasons before explained (§ 266), sometimes peculiarly determines blood to the head. But without the patient being conscious of palpitation, there may be determination of blood to the head; and in numerous observations, I have found this to be so commonly present, that I believe it to be the common immediate cause of the sudden paroxysms of various kinds of disorder which affect the nervous centres. Infantile and puerperal convulsions are probably to be included in this remark, although they may be connected with very different conditions of the vascular system in point of fulness, and are promoted by an imperfectly purified condition of the blood itself (§ 249).

324. But the most common cases of determination of blood are those caused by the application of stimuli. Thus heat causes a flow of blood to the surface; snuff, to the nose and eyes; spices in the mouth, to the

salivary glands; food in the stomach, to its secernent vessels; purgatives to the vessels of the intestines, and those of glands connected with them; diuretics, to those of the kidneys, &c. &c. In fact, in the operation of most medicines, there is an increased flow of blood to particular organs or surfaces; and there are few diseases unconnected with local determination of blood. We shall find hereafter that it occurs in inflammation as a part of that complex process; but Dr. Parry was wrong in supposing that inflammation consisted in this alone.

325. Now, what is the physical cause of determination of blood? In some cases, increased action of the heart (§ 112) may propel the blood with unusual force and quantity to the arteries in its immediate vicinity; more particularly when there is little blood in the system, and that little accumulates chiefly at and near the heart, as in cases of anæmia (§ 266), or in the commencing reaction after great congestion of internal organs as in the beginning of the hot stage of fevers; and thus determination of blood to the lungs and bronchi, the neck, and head, is a common result of inordinate action of the heart. But in many of the examples above cited (§§ 323, 324), local determination takes place without any increase of the heart's action, and must therefore be due to another cause.

Is such determination of blood caused by *increased* action of the arteries? The only active property which we know these vessels to possess is that of slow or tonic *contraction* (§ 120); and such contraction of arteries leading to a part, would diminish instead of increasing the motion and quantity of blood proceeding to the part (§ 294).

326. We may affirm, from direct observation as well as from reasoning, that determination of blood is caused by *enlargement of the arteries;* and this enlargement is the effect of the pressure of the arterial distension from behind acting on a tube which has lost some of its contractile power (§ 120). The tonicity of the arteries makes them naturally resist the distending influence of the mass of blood pumped into them by the heart; but if the tonicity be impaired in any artery, that of other arteries forces into it the blood in augmented quantity, by which it is dilated, and becomes an enlarged channel for the transmission of more blood and more force (§ 323). If the artery be thus enlarged, the capillaries and veins leading from it will be also enlarged, and will share the increase of blood and motion thus supplied to them (§ 298, *note*). We find the proof of the enlargement and distension of arteries leading to an inflamed or irritated part in their increased and harder pulse; the coats of the vessels being stretched to tightness, the pulse is no longer softened by the usual elastic spring.

So, too, in the frog's web gently irritated by an aromatic water we see the arteries become enlarged, supplying a larger and more impulsive flow of blood to the capillaries and veins, which all become enlarged also; and the whole vascular plexus, including vessels which before scarcely admitted red particles, then become the channels of a much increased current. This is determination of blood.[1]

[1] As these phenomena have not been distinctly described by observers apart from the farther effects resulting from over-irritation, which leads to obstruction and inflammation, I will state shortly some results of many observations on the circulation of a frog's web, under the influence of moderate stimuli applied to it. These observations were made in

It has been objected that I assume enlargement of vessels to be the cause both of increased motion (in determination), and diminished motion

the summer of 1841, and some of them are mentioned in my Gulstonian Lectures, published in the *Medical Gazette* of July, 1841.

The arteries may be distinguished from the veins in the frog's web, not only by the direction of their current and its greater rapidity and transparency, but also by a series of lines along their course, marking the size to which they have been distended at some previous time. (See A, Fig. 1.) These lines or channellings are most distinct, and are more remote from the artery at its angles or bifurcations. They are to be seen at some points along the veins, but much less distinctly. Now these lines are in themselves proofs of the varying distension of the arteries, and they also furnish the means of measuring this varying distention.

Fig. 4.

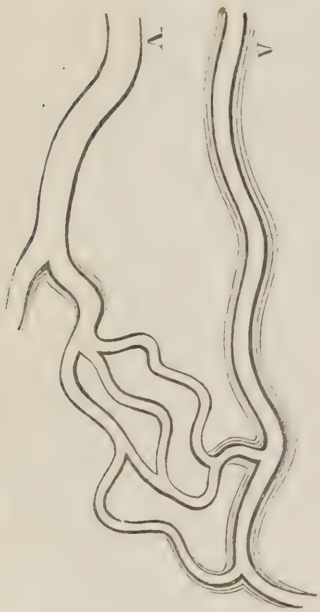
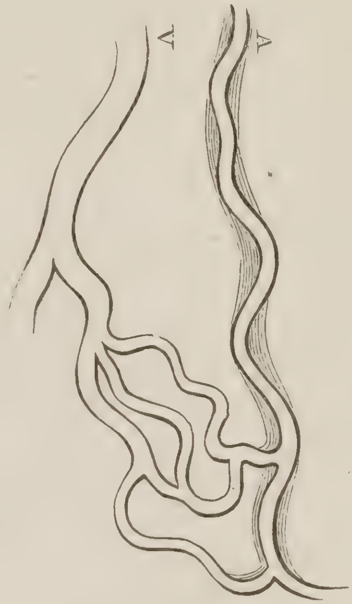


Fig. 5.



When a weak infusion of capsicum is applied by a camel-hair pencil to the web, there is a momentary retardation of the current in the veins, and the artery distinctly shrinks in size. But in a few seconds the reverse takes place; the artery swells to beyond its former size, and reaches the outmost line of its channel; the flow of blood through it is too rapid to be distinguished, and all the capillaries present a scene of busy motion; in some, the particles passing in numbers and speed greater than the eye can appreciate; in others before invisible, single files force their way in more deliberate, but continuous motion; whilst in the veins the movement is again more rapid. This motion soon begins to flag, and becomes remittent or oscillatory in some capillaries; and it is seen that the arteries have already begun to shrink in size, and the channelled lines which they had reached reappear. Sometimes, in shrinking, the artery assumes for a time a more tortuous shape than before (as A, in Fig. 2): so that its walls cease to be parallel with the lines, which seem to show that it contracts in diameter, before its length is proportionally reduced. The contraction of the artery, and consequent reduction of the quantity and movement of the blood in the vascular plexus, was promoted by repeated applications of cold water (§ 124); which in some instances stopped the motion of the blood altogether, by contracting the artery to so small a size that no blood-particles entered it. A solution of acetate of lead also produced this effect.

The determination of blood thus excited produces an increased redness quite visible to the naked eye, but it is less intense and of lighter hue than the redness of inflammation or congestion.

(in congestion), which seems contradictory; but if the objector had duly considered my explanation, he would have found no contradiction in it. In determination, the vessels enlarged are the arteries, which, being near to the source of motion, and highly charged with its propulsive power give vent to the current as from a reservoir under high pressure; whereas in atonic congestion the vessels enlarged are the veins and capillaries, which are remote from the source of motion, and receive their impulse only through the arteries, which are not enlarged, or are even contracted (§ 294); and thus the accumulated blood becomes comparatively stagnant. There is nothing contradictory in this simple application of hydraulic principles; and it is farther illustrated by the fact, that those parts are most liable to determination of blood which are nearest to the source of power; thus the arteries of the head, face, and neck present this phenomenon much more frequently than those of the lower extremities.

327. There appears, then, to be no difficulty in tracing local determination of blood to the physical cause, enlargement of the arteries, leading to the affected part; and if it is not equally easy to give a physiological explanation of the cause of this enlargement, it is only because the laws of atonic contractility of arteries have not yet been sufficiently studied. The terms "active dilatation" (Hunter), and "vital turgescence" (Kaltenbrunner), have been applied to the condition in question; but all that is known of animal physics is opposed to the possibility of there being a power of active dilatation in the arteries.

The physiological cause seems to be a weakening or reduction of the tone (§ 123) of the artery; so that it becomes passively distended by the vis a tergo of the heart and arteries. In some cases, it might be supposed that this weakness is the result of exhaustion from stimulation (§ 116); and it has been stated above that a momentary contraction of the artery precedes its dilatation. But the dilatation is out of all proportion to the previous contraction; and, in some cases, as in blushing, in the operation of heat, and in the growth of parts, there is no sign of any previous contraction.

328. Dr. Billing ingeniously conceives that, by stimulating the nerves, the nervous influence is drawn away from the vessels; and that their contractility, being derived from this influence, is thus impaired. But this view assumes that muscular irritability, even in its lowest form, tonicity, is a property derived from the nerves—an assumption unwarranted by the facts and opinions most generally received by physiologists (§ 110). There can be little doubt that the nerves—especially the sympathetic (§ 152)—are sometimes concerned in causing determination of blood; and it is not improbable that their influence is that of reducing the contractility of particular arteries, just as strong moral emotions, acting through the nerves, paralyze the sphincters and muscles of voluntary motion (§§ 144, 154). So, too, we have found that heat, which in moderate degree increases the irritability of muscles, impairs their tonicity, and cold has the reverse effect (§ 120). But the laws of tonicity, and its relation to the nervous influence, require farther investigation.

329. We can readily understand the *final* cause of determination of

blood. "Ubi stimulus, ibi fluxus." The flow is intended to support the well-being and function of the part. If any influence disturb its well-being, or excite its function, more blood is wanted; the arteries dilate to supply more, and in greater force, and thus the circulation through the part is augmented. The result is, in moderation, to increase the redness, warmth, sensibility, secretion, nutrition, and other functions of the part; in excess, to disorder and alter them.

330. We have hitherto considered local determination of blood as resulting from causes which directly affect that part of the vascular system in which the determination takes place. In not a few cases, however, the same result arises from opposite causes acting on other parts of the vascular system. Thus as we found external cold cause internal congestions by intropulsion (§ 292), so too it may occasion internal determinations of blood. By constricting the vessels of the surface and extremities, it directs the force as well as the quantity of the circulating fluid on internal parts, or those beyond its influence. Thus, in many persons, cold to the surface and extremities causes palpitation, dyspnœa, pain in the chest, throbbing, pain and heat in the head, gastralgia, colic, and fluxes of various kinds. It is obvious that, in such cases, the force of the heart is expended chiefly on the arteries of the internal organs, which thus become dilated, and the seat of determination of blood; whilst those of the surface and extremities are contracted and bloodless. The commencement of reaction from the cold stage of a fever is commonly marked by determination to the head and other parts near the centre of the circulation, which are thereby excited, and suffer more or less pain and disorder.

The subjects in whom cold causes internal determinations of blood, are chiefly those endowed with much irritability of heart (§ 113), and with but little blood (§ 261). The same persons likewise are liable to a flush of blood to the face and head, with coldness of the feet, when they go into a warm room. By cooling the head, the feet become warm; or by warming the feet, the head cools.

331. Attacks of local determination of blood, from other causes, are often accompanied by shivering fits, pallidity, coldness of the extremities, and defective secretions, particularly in persons of weak circulation. When an unusual quantity and force of blood is determined to one part there must be less in other parts, which therefore suffer from the deficient supply. This furnishes an important therapeutic indication, to be noticed hereafter.

332. As we find determination of blood to be chiefly produced by an enlargement of some arteries from a reduction of their tonicity (§ 326), so we may be led to expect that such enlargement may affect any part of the arterial system. We have chiefly considered it in relation to the distribution of blood to parts; but it may also occur in the great arterial trunks. Inordinate pulsation of the aorta, especially in the abdomen at the cœliac axis, or at the bifurcation into the iliacs (corresponding with a little below the epigastrum and at the umbilicus), is a common symptom in nervous subjects. Epigastric pulsation, I have observed frequently before and after hæmatemesis. In several cases nephralgia,

hæmaturia, and lithic deposits in the urine occurred in patients affected with strong pulsation at the umbilicus.

SYMPTOMS AND EFFECTS OF DETERMINATION OF BLOOD.

333. Many of the symptoms of determination of blood may be learned from the preceding illustrations. It generally causes a flush of heat, and exalts contractility (§ 112), sensibility (§ 126), and other nervous properties (§ 149) of the part, exciting spasm, pain, irritation, and sympathetic disorder. In its moderate degrees, it increases the natural secretions of the part (§ 162), and thus becomes the cause of mucous, bilious, and urinary fluxes, &c. The nutritive function is a slow process, and only affected by determination of blood when constant or often repeated; then it is likewise increased, and more naturally than from congestion, the result being a more simple and general hypertrophy of the part. The process of absorption, although favored when the current is accelerated without distension, is often not equal to the effusion. Hence in sacs and cells determination of blood may cause dropsy.

A few examples will suffice to illustrate the symptoms and effects of local determination of blood.

334. The parts most subject to determination of blood are those nearest to the heart, and those most freely supplied with bloodvessels (§ 30), as the brain, the parenchyma of glands, mucous membranes, and the skin.

335. Determination of blood *to the head* often takes place in some persons from mental excitement, violent exertion, stimulant drinks, or defective excretion. The symptoms vary considerably; but increased beating of the carotid and temporal arteries, some flushing of the face and suffusion of the eyes, and an increase of the symptoms on stooping or lying with the head low, are commonly present in all cases. The other symptoms are sometimes those of simple excitement of the nervous centres, painful throbbing in the head, excessive sensibility to light and sound, flashes in the eyes, noises in the ears, an excited state of the mind, rapid flow of ideas, sometimes bordering on delirium, wakefulness or dreamy sleep, restlessness and irritability of temper. Sometimes these symptoms are replaced by others indicating a temporary oppression of nervous functions, such as giddiness, drowsiness, stupor, imperfect vision and hearing, with apparent specks or mist in the eyes, impaired articulation and power of locomotion, occasionally with various convulsive affections, as in hysteria and epilepsy.

336. It may seem difficult to explain how such opposite symptoms, those of excitement and those of oppression, are produced by the same cause—determination of blood. But the explanation is readily found on referring to the true nature of determination, and the different modes in which it affects the circulation within the head. Moderate excitement of the brain, as by bodily exercise, mental exertion, or certain beverages, such as tea or coffee, is accompanied by increased but equal flow of blood through the brain. But if these or other causes of excitement operate in excess, the arteries supplying the brain are still farther dilated, and

convey blood to it with more force without an equal increase in the passage of the blood *through* it; and this for two reasons. 1. We have already found that a certain proportion in the size and elasticity of the vessels best qualifies them to transmit blood freely (§ 301); and that where this is wanting, increased force does not compensate for it, but often causes new disorder. Thus in violent palpitation of the heart, the aorta, carotid, and subclavian arteries are often dilated, and throb strongly; but the weak pulse at the wrists shows that much force is expended on the larger trunks, without reaching their distant branches. This too is one reason why, in determination of blood to the head, the force is sometimes more expended in the larger vessels at the base of the brain than transmitted throughout its substance. 2. Another reason for unequal or defective excitement from determination of blood to the head, is the unyielding nature of the skull, which permits no considerable enlargement of any of the vessels within it, without a corresponding diminution of other vessels, and a general compression of the cerebral substance. Hence distension of the arteries, beyond a certain degree, will compress and obstruct the small veins, and thus prevent that freedom of circulation on which functional activity depends. On these principles may be explained the production of symptoms of depressed as well as excited energy of the nervous centres, and often a mixture of both, from the same cause, determination of blood (§ 153).

337. Determination of blood *to the kidneys* is caused by stimulating diuretic drinks, and, besides the increased flow of urine, may produce pain in the loins and throbbing in the abdominal aorta; and the urine discharged may exhibit an increase not only of its water, but also of its acid matter, with more or less of the epithelial cells of the uriniferous tubes. Excitement of the circulation, by exercise or by nervous affections, also reaches the kidneys; exercise carries off much fluid by the skin; but nervous excitement, where it fails to cause perspiration, determines more to the kidneys, and this seems to be the source of the abundant flow of limpid urine which follows convulsive and other nervous affections. External cold operates in a similar manner, by constricting the superficial and extreme vessels; it directs the blood in unusual quantity and force on internal organs, especially the kidneys; hence enuresis.

338. Determination of blood *to mucous membranes* is exemplified in certain forms of dyspepsia, in which sudden pain, or heat, or nausea, is felt in the stomach, accompanied by epigastric pulsation, and sometimes followed by eructation of sour or other liquid, and sometimes by hematemesis. These attacks are often induced by excitement, general or local, from irritant ingesta, and from external cold. In the intestines, a similar affection causes a diarrhœa; in the air-tubes, bronchial flux; the common character of these affections being their sudden production under the influence of various exciting agents.

339. Determination of blood *to the skin* is often produced, not only by direct irritation, but from the influence of internal causes; as in case of blushing from mental emotion, flushing of the face from acid in the stomach, and the general redness of the surface in reaction after cold or at the commencement of fevers. In various chronic skin-diseases,

the effect of determination is seen in a brightening of the color of the eruption, which may take place in a few minutes.

340. Determinations of blood are commonly transient, coming on suddenly and soon subsiding. When they are more permanent, they commonly lead to other disorders. In their immediate seat, they cause either increased secretion, with the addition of more or less of the watery saline, and albuminous parts of the blood, or hemorrhage, or they may pass into inflammation. In other parts of the body, there is often, at first, coldness, and defective circulation and function (§ 330), but afterwards they may succeed a febrile reaction, with hot skin, accelerated pulse, scanty secretions, and other symptoms of inflammatory fever.

341. The frequent recurrence of determination of blood, or its long continuance in a lower degree, affects the structure; increased nutrition, hypertrophy, being the result. This may be a natural kind of hypertrophy, as in the case of muscles, which augment in size in proportion to their exercise, which increases the circulation of blood through them. So the uniform hypertrophy of the substance of the heart, and of other organs, after long-continued excitement of that organ, may be referred to the increased determination of blood that has been kept up. In other cases parenchymata, as those of the kidneys and liver, exhibit alterations rather than mere growth; and albuminous deposits and granular degeneration result. In these and other cases, the effect on the structure is commonly modified by the occasional presence of congestion, inflammation, and the plastic condition of the blood itself (§ 211).

It is unnecessary to dwell farther on the phenomena and results of determination of blood, as we shall have to advert to them in connection with its occasional results—flux and hemorrhage, and with inflammation, of which it is a component part.

REMEDIES FOR DETERMINATION OF BLOOD.

342. In the treatment of all cases of determination of blood, as of diseases in general, it is obviously proper, as much as possible, to remove the exciting causes. Thus, in the numerous class of cases arising from the action of stimuli or irritants on the part which is the seat of the determination (§ 324), the removal of such irritants, or the diminution of their action by soothing or diluent remedies, is a first indication.

343. If we are correct in tracing local determinations of blood chiefly to an atonic distension of the arteries supplying the part (§ 326), we may expect measures which promote their contraction to be efficient remedies. This is the fact; for cold is one of the most effectual means which we possess for subduing determinations of blood; and this was mentioned as a chief remedy for the element, defective tone (§ 124). Astringent agents are equally useful in some instances of local determination; as in the application of solutions of acetate of lead, sulphates of zinc and copper, nitrate of silver, and other astringent lotions to external surfaces (§ 326, *note*); but these are chiefly effective where the determination is quite local and unconnected with generally increased circulation, otherwise they become irritants rather than astringents (317). But besides cold and other astringents to the part which is the

seat of the determination, and to the arteries leading to it, *derivants*, or means which draw away blood by relaxing other parts of the vascular system, are especially indicated by many preceding observations (§§ 330, 331, 340). Of these derivants, heat is the most effectual, especially when combined with moisture.

344. Thus cold lotions or douche to the head, and the hot foot-bath, are among the best remedies for determination to the head. Taking copious draughts of cold water, or more sparingly of iced water, will often relieve epigastric pulsation and palpitation of the heart. The warm-bath, by deriving to the surface, will diminish the flow of blood to the kidneys. I have known severe nephralgia instantly relieved by cold affusion on the loins; but the practice is too hazardous to be recommended.

345. Various evacuant remedies may also be employed to counteract determination of blood, by determining a flow in another direction; and thus purgatives, diuretics, and diaphoretics are often useful. Of these, purgatives are by far the most powerful and sure in their operation, and are of great efficacy in determinations to the head. Change of posture, by elevating the part which is the seat of determination, may sometimes be usefully practised.

346. But the most powerful derivant is bloodletting, general or local. By the microscope, it may be seen how opening a bloodvessel changes the currents of blood; the currents of many vessels are reversed and drawn towards the bleeding point, whilst in others they are retarded where they were before running with great speed. But bloodletting is unnecessary and injurious in many cases of determination of blood, especially those attended with a deficiency of blood in the whole system, and, as we have seen, such cases are not rare (§ 330). Dry cupping is a good substitute in some instances; but even this measure is more weakening than it is generally supposed to be; for much blood being extravasated into the skin and cellular texture, is really lost to the system as blood; its particles are changed, and their structure destroyed.

The cases in which bloodletting should be used are those where determination to an important organ is combined with some general plethora or local congestion, or has continued so long as to threaten a termination in inflammation. A speedy blood-drawing, as by cupping or free venesection, will generally answer best.

347. In the same class of cases, certain remedies are useful which seem to cause a general relaxation of the tonic fibres (§ 122) of the vascular system and an equalization of the force and blood which this system conveys (§ 331). Antimony is the chief of these; and it is most indicated where febrile reaction has begun.

348. Another class of remedies suitable for determination of blood, attended with much excitement, are sedatives, or those which reduce the heart's action (§ 115), such as digitalis, hydrocyanic acid, and nitre. These are chiefly useful where the determination occurs in connection with palpitation, as in the case of the various convulsive or other sudden nervous attacks which I have proved to be so commonly excited by palpitation (§§ 322–3). I have entirely cured several cases of convulsive hysteria, and much reduced the frequency of the fits in epilepsy, by

these remedies, sometimes combined with cold affusion on the head in the morning, and the hot foot-bath at night (§ 331). Hydrocyanic acid probably operates chiefly on the organic excito-motory nerves, and by lowering their function prevents the undue excitement which they communicate to the heart. In this respect it surpasses conium and hyoscyamus, which are also sometimes useful in preventing determination of blood arising from nervous excitement.

349. We have found (§ 330) that in many instances determination of blood to internal organs results from weakness of the circulation, and especially a want of tone in the whole vascular system (§ 123); so that under the operation of cold constricting the external vessels, or of irritations exciting internal organs, the latter monopolize most of the blood and force of the heart's action. In such cases, besides temporary means to equalize the circulation (heat to the extremities and surface, cold and astringents to internal organs, gentle exercise, friction, &c.), more permanent remedies are to be sought in tonics, and various particulars in diet and regimen, which give strength to the contractile fibre (§ 124), and improve the quantity and quality of the blood (§ 271).

Thus preparations of iron and bark are useful remedies in cases of the weaker kind; mineral acids, iodide of potassium, mild bitters, and the slighter metallic tonics, nitrate of silver, sulphates of zinc and copper, are serviceable in others which will not bear the stronger tonics. In the use of any of these remedies, it is necessary to guard against their exciting effects on the parts which are the seats of determination, by premising or conjoining the temporary remedies (§ 342, &c.) against that condition, and by keeping the secretions free and equally balanced.

In all cases, country air, and exercise suited to the strength of the patient, and habits of posture opposed to the peculiar determination, will be found useful in removing and preventing this morbid affection.

SECTION VI.

RESULTS OF HYPERÆMIA.

350. Before we proceed to the third and more complex variety of local hyperæmia, inflammation, we must notice some remarkable results to which the other varieties, when increased to a certain degree, tend, when yet short of the conditions necessary to constitute inflammation—I mean *hemorrhage, flux, and dropsy*. These results have been already mentioned as sometimes ensuing from plethora, congestion, and determination of blood; and in describing hemorrhage, dropsy, and flux, it will be unnecessary to do more than exemplify their occurrence in connection with these proximate elements, and to trace the farther peculiarities which distinguish each of these results.

I. HEMORRHAGE.

351. When, in any form of hyperæmia, the bloodvessels are distended to a great degree, they sometimes give way, and blood is effused. I

shall give illustrations of the more common cases of hemorrhage proceeding from the several kinds of hyperæmia which have been already described.

General plethora (§ 275) not unfrequently causes hemorrhage from the nose (*epistaxis*), from the stomach (*hæmatemesis*, vomiting of blood), from the rectum (*hæmorrhois*), and into or upon the brain (*apoplexy*). The operation of each of these, except the last, is more commonly favorable than otherwise, in reducing the excessive fulness of the bloodvessels; but they may be attended with unpleasant symptoms, and require control.

352. Congestion from *venous obstruction* (§ 289) produces hemorrhage in the cases of *pulmonary apoplexy* (hemorrhage into the parenchyma of the lungs), from obstructive disease of the left side of the heart; bronchial hemorrhage and *hæmoptysis* (spitting of blood) from tubercles in the lungs; hæmatemesis and bleeding piles from obstructions of the liver from disease or violent straining.

353. Congestion from *weakness of the vessels* (§ 290) often causes hemorrhage in various dependent parts, in congestive fevers, and in various passive hemorrhages of weak subjects. A stooping posture has been known to cause cerebral hemorrhage (apoplexy). The erect posture may bring on uterine hemorrhage (291).

354. The congestion of the head from the intropulsive operation of cold (§ 292), sometimes leads to epistaxis and apoplexy; that from previous excitement of the stomach and kidneys in drunkards (§ 294), occasionally causes hæmatemesis and *hæmaturia* (bloody urine). The congestion of the kidneys in scarlatina, and in the cold stage of ague, is sometimes followed by hæmaturia.

355. Hemorrhage, from determination of blood (§ 322), is exemplified in cases of epistaxis and apoplexy, preceded by increased beating of the carotids, flushing of the face, &c. (§ 335); hæmatemesis from various irritants in the stomach (§ 338); hæmaturia from stimulant diuretics (§ 337); bloody dysentery from drastic purgatives, &c. (§ 324). So also we shall find hemorrhage to be a common concomitant or result of inflammation.

356. But all cases of general or local hyperæmia now noticed, do not result in hemorrhage; some additional element is wanting; and this additional element may be either in the *bloodvessels* or in the *blood*.

357. The bloodvessels are sometimes obviously in a diseased state. Inelastic and fragile from osseous or atheromatous deposit, or aneurismal dilatation, the arteries of the brain become ruptured under the influence of congestion or determination of blood. Softened and lacerable from inflammation or mal-nutrition, bloodvessels give way in various structures; and in this way, hemorrhage occurs from an inflamed stomach or colon, in tuberculated lungs, in a softened brain, and in a diseased uterus. Sometimes, actual ulceration or suppuration opens an artery or vein, and this is not a very uncommon cause of hemorrhage in chronic ulceration, in suppuration of lymphatic glands or tonsils, and in malignant disease of the stomach, intestines, and uterus. Mechanical injury may rupture bloodvessels in the kidneys and nostrils; hence the hæmaturia and epistaxis which sometimes follow violent blows in the loins or on the

nose. I have repeatedly known hæmatemesis to ensue from the act of lifting a heavy object from a height, which, with peculiar force, compresses the liver.

358. In other instances, the hemorrhagic disposition can be traced to a peculiar state of the blood, which is defective in fibrine (§ 196), but abounding in red particles (§ 184), as in petechial fevers, congestive apoplexy, hemorrhagic smallpox, and other exanthemata. But there are other cases, in which the disposition to hemorrhage prevails without any defect of fibrine, or excess of red particles; scurvy and purpura are examples. In the former, there is found to be the very reverse of these changes (§§ 185, 196).[1] It appears probable that an alteration in the *quality* of the red particles (§ 186) and fibrine (§ 203), is the real evil in these diseases. The readiness with which textures become stained with the coloring matter, the purple, brownish, or party-colored stains left by inflammation, and, in extreme cases, the altered appearance of the blood itself, seem to show the coloring matter to be diseased; the failure of the healing process, and the remarkably loose and blood-stained appearance of fibrinous coagula, which form on the spongy gums or in wounds, seem to indicate a want of contractility and vital plasticity in the fibrine (§ 211). Farther microscopic observations are wanted on these subjects; some have already been noticed (§§ 187, 203).

359. Another question connected with hemorrhages relates to the mode in which the blood is effused. We have just seen that, in some cases, bloodvessels are distinctly ruptured (§ 357). But in other instances, blood has been poured out in considerable quantities from various mucous surfaces, and even from the skin, without any discernible breach of vessels, or even of the surface. This statement has been made, particularly in regard to epistaxis, hæmatemesis, and some remarkable cases of hemorrhage from the skin, occurring successively at different parts of the body. Considering the size of the red particles of the blood, and the absence of any visible pores in the walls of the bloodvessels, even under the highest magnifying powers, it does not appear possible that the particles can escape from the vessels without rupture either of the particles or of the vessels. At the same time, it may be stated that in the frog, the red particles do pass through capillaries of caliber smaller than their short diameter; and in so passing, I have often seen them rolled up in the manner of an ice wafer. J. Hewson noticed the flexible and extensible property of the red corpuscles, and it has been confirmed by his commentator, Mr. Gulliver. The appearances of capillary apoplexy (cerebral hemorrhage), and hemorrhagic inflammations of serous membranes, countenance the opinion that many minute vessels become ruptured at once, probably in connection with an altered condition of the blood; and such minute ruptures occurring in membranes, would not be discernible by common modes of examination. All cases of this description which have lately come under my notice, have included the element already noticed, an altered state of the blood

[1] In acute hemorrhagic purpura, the fibrine is not deficient, for I have found the blood effused under the skin firmly coagulated. I have before mentioned my experience that purpura is generally connected with imperfect action of the liver (§ 171).

(§ 358), generally of the nature of uræmia (§§ 171, 249) or cholæmia (§ 250).

VARIETIES OF HEMORRHAGE.

360. Besides differences in seat, hemorrhages are distinguished into *active* or *sthenic*, and *passive* or *asthenic ;* and the peculiarities of these varieties may be traced to the same elements as the corresponding varieties of general and local hyperæmia (§ 279), excess and defect of the contractile power of the heart (§ 110), and of the tonicity of the arteries (§ 120). Thus hemorrhages, preceded or accompanied by the symptoms of sthenic plethora (§ 280), or with determination of blood (§ 322), are *active* or *sthenic ;* whilst those occurring in connection with asthenic plethora (§ 281), or with mere congestion (§ 287), are *passive* or *asthenic.* We may, therefore, refer to the symptoms described under these subjects for the precursory symptoms of each kind of hemorrhage.

361. But when the hemorrhage begins, it may modify the previous symptoms in various ways, besides the new local signs which the discharge of blood produces. In active hemorrhage, the full, hard pulse of sthenic plethora becomes modified by a remarkable jerk or thrill, which is an important symptom where hemorrhage is only suspected. I have noticed this thrill in the pulse even when the loss of blood has been very trifling, and where no murmur accompanies the heart sounds; and I am therefore inclined to think that it depends on an unusual abruptness of the heart's contraction (§ 113), combined with irregularities in the tonicity of arteries in different parts (§§ 326, 332); which cause these to react in successive jerks at each pulse, instead of simultaneously. In fact, this same thrill sometimes is felt during a paroxysm of determination of blood to a part without any hemorrhage resulting.

361. If the quantity of blood effused be large, and especially if its loss be rapid, syncope, or various degrees of faintness and weakness, may ensue. The pulse becomes small, weak, and often irregular, the surface and lips pale; either consciousness, or the heart's action, may first fail, according to the posture of the patient (§ 70), and the condition of anæmia (§ 262) is induced.

362. Even after this faint state has been induced, in the course of a few hours the increased action (reaction) returns; and it is under the influence of this that the pulse exhibits the greatest degree of the jarring or vibratory character; so that it may feel like a loose wire twanging, or a rough file drawn under the finger. With this state of the pulse, palpitation, throbbing of the great arteries, and the various symptoms of partial nervous excitement described under the head of anæmia, sometimes occur (§ 265). During this reaction, the hemorrhage may be renewed.

363. If the hemorrhage is inconsiderable, or if it be suddenly checked by styptics before the vascular fulness or determination has been reduced, inflammation may ensue, with increasing strength and hardness of the pulse, heat of skin, and other symptoms of inflammatory fever. On the other hand, hemorrhage to a considerable extent may remove the hyperæmia, and the various local and general symptoms of oppres-

sion, fulness, tightness, pain, and functional derangement which it had produced. Thus we find headache and flushing often relieved by epistaxis; pain and oppression in the chest by hæmoptysis; abdominal pain and pulsation by hæmatemesis, melæna, or hemorrhoidal flux.

364. But the blood effused may produce various disturbances and symptoms in the parts into which it is effused. Within the head it presses on the brain; and by interrupting the circulation through it, it may cause coma or paralysis (§ 273); or it may also break up the substance of the brain, and cause death by syncope (§ 116) and asphyxia combined. In the lungs, the blood may at once suffocate by its quantity, or cause dyspnœa and cough until it is expectorated. Here, too, it sometimes breaks up the texture of the lungs, leading to serious disorganization. In glands it forms swellings, or is mixed with and modifies their secretions, as in the case of hæmaturia. In other complex textures, it produces swelling, often followed by local inflammation, as instanced in the cutaneous swellings of purpura hemorrhagica.

365. Passive or asthenic hemorrhage may be preceded by symptoms of asthenic plethora (§ 281) or congestion; may be accompanied by symptoms of exhaustion if the loss is profuse, of relief if it be moderate; and anæmia may ensue from excessive loss; or reaction, sthenic hemorrhage, or inflammation, if the hemorrhage is too suddenly checked. The hemorrhage connected with an altered state of the blood, is generally of the passive kind, although excitement, or determination of blood (*molimen hæmorrhagicum*), sometimes comes on here also.

TREATMENT OF HEMORRHAGE.

366. As hemorrhage is commonly a result of plethora, congestion, or determination of blood, the remedies for these morbid elements will be more or less needed in its treatment. But the necessity for using these remedies will much depend on the extent and seat of the hemorrhage, and the mischief likely to result from its continuance. For example; a moderate epistaxis or hemorrhoidal flux needs no treatment; it is a natural cure for a previously existing hyperæmia. But if these hemorrhages be profuse, whether of the sthenic or asthenic kind, they must be restrained; if sthenic, by artificial bleeding, which is under control, and by derivants to other parts, to reduce the fulness which causes the hemorrhage; if asthenic, by stypics, combined with derivants, to save the blood, the loss of which is injuring the system.

367. But in some cases, hemorrhage to any amount may be injurious, and should be opposed from the first, both by remedies for the hyperæmia, which is the cause of the hemorrhage (§ 345, *et seq.*), and by styptics, which peculiarly counteract this result. Thus hemorrhage from the lungs, or into the brain or other organ, requires prompt interference. The same rule may be applied to cases of excessive hemorrhage of any kind in all cases, and of more moderate hemorrhage in very weak subjects; in all of which the loss of blood is a pressing danger.

368. In *active* hemorrhage, generally, bloodletting may be used until the hemorrhage is arrested or the pulse reduced; and this effect should

be sustained by other evacuants, especially purgatives and diuretics. Remedies which diminish the power of the heart, such as digitalis, hydrocyanic acid, and nitre, and those which also reduce the tonicity of the arteries, especially antimonial medicines, are likewise of great use in some active hemorrhages. Another powerful agent in hemorrhage, connected with increased action or determination of blood, is cold (§ 343). Thus ice, or a stream of cold water on the nose and forehead in case of epistaxis, ice, swallowed in hæmatemesis, ice applied externally, or icy water injected, for uterine hemorrhage is of considerable efficacy (§ 344). I do not approve of the practice recommended by some, of applying ice to the chest for hæmoptysis; I have seen pneumonia thus induced. Cold water is sometimes very effectual in arresting the flow of blood from a wound, and Dr. O. Rees has suggested that, in addition to its constringent operation on the vessels, it may arrest the capillary circulation by causing the red particles to swell up by endosmosis.

The treatment of *passive* or *asthenic* hemorrhage, besides styptics to prevent excessive loss of blood, will include remedies for general plethora (§ 286), or local congestion (§ 313, &c.), which may cause the hemorrhage. Hence, general or local depletion, derivants, accompanied or followed by tonics, may be useful.

369. We have now to consider the means calculated to restrain all kinds of hemorrhage, and which are especially opposed to the causes which more immediately determine this result of disordered circulation (§ 356). If bloodvessels are softened, brittle, or actually ruptured or ulcerated (§ 357), a chief thing to be done is to diminish the quantity of blood sent to them; and besides by bloodletting, this may be effected by pressure, posture, cold and astringent applications, and means calculated to tranquillize the whole circulation. Thus epistaxis is sometimes arrested by pressure on the carotids; uterine hemorrhage, by pressure on the abdominal aorta, or by elevating the pelvis; hæmoptysis, by keeping the chest high; and in all cases of hemorrhage, perfect stillness and a cool regimen should be observed.

370. The other pathological condition which favors hemorrhage, the altered state of the blood (§ 358), is, perhaps, more directly influenced by the remedies called styptics. Most of these remedies are astringents causing contraction of the tonic fibres of vessels and other parts, but some of them also coagulate the blood, and in both these ways, they may tend to restrain hemorrhage.

Of those which cause both contraction of the vessels and coagulation of the blood, the most powerful are acetate of lead, alum, sulphate of copper, chloride of zinc, nitric and sulphuric acids. Other styptics, as nitrate of silver, sulphate of zinc, sulphate of iron, and infusion of nutgalls, are certainly astringent, and are generally supposed to coagulate the blood; but Mr. Blake's experiments show that they have not this latter effect, when injected into the veins of living animals (see *note* to § 214). It is, however, possible that, in a concentrated form, as where applied topically, they may coagulate the blood in the bleeding vessels. This seems to be the effect of nitrate of silver when applied to leechbites. The actual cautery operates in a similar way.

In some cases of hemorrhage, the styptic remedies may be applied

directly to the bleeding part, as in epistaxis, hæmatemesis, hemorrhoids, and uterine hemorrhage. In epistaxis, solutions of alum, acetate of lead, and sulphate of zinc are sometimes injected into the nostrils, or applied by sponge or lint. In hæmatemesis, sugar of lead, alum, gallic acid, oil of turpentine in small doses, and the mineral acids, given by the mouth, operate directly on the bleeding part. In excessive hemorrhoidal flux, enemata, containing some of these remedies, are immediately beneficial.

371. In many instances, the bleeding part is beyond the reach of the direct application of styptic remedies; yet some of these, administered internally, show considerable power in restraining the hemorrhage. Thus hæmoptysis is assuredly sometimes checked by frequently repeated doses of sugar of lead (which should be combined with a little opium or conium, to prevent its griping the bowels); and according to some practitioners, by ipecacuanha, gallic acid, alum, and other astringents. Hæmaturia of the passive kind is diminished by small doses of oil of turpentine; passive uterine hemorrhage, by gallic acid, ergot of rye, and tincture of the sesquichloride of iron. Opium given internally, has been found effectual in some cases of uterine hemorrhage. It is difficult to explain how it operates; but it is probably through that property by which it diminishes many secretions.

372. In some kinds of hemorrhage, especially those of the intestinal canal, the most effectual remedies are those which increase the proper secretions of this canal, and of its allied glands; such as mercurial and saline purgatives, in combination with others of a styptic kind, such as sulphuric and nitric acids, alum, and sulphate of zinc. This mode of treatment is often sufficient in slight hemorrhages, or dispositions to hemorrhage, from the lungs and uterus, and in purpura hemorrhagica; and there can be little doubt that it operates on the condition of the blood, as well as by its evacuant and styptic effects.

II. FLUX AND DROPSY.

373. Another result of various kinds of hyperæmia, is an effusion of the watery part of the blood, with more or less animal and saline matter in solution. This result, occurring in secreting organs or open surfaces, constitutes *fluxes;* in closed sacs or cellular texture, it constitutes *dropsies.* There is so much that is in common in the pathology of fluxes and dropsies, that we shall avoid repetition by exemplifying them together in the first place; and we can afterwards notice their distinguishing peculiarities.

374. General plethora sometimes ends in flux or dropsy; but such a result most commonly ensues where the bloodvessels are temporarily distended with an undue proportion of watery contents. Thus, if much water be slowly injected into the veins of an animal, the circulation and breathing become embarrassed; and after a time, dropsical effusions take place into the abdomen, the chest, and the cellular texture; or a flux (excessive flow) takes place from the kidneys, intestines, or skin; or all these results may occur; and the bloodvessels are relieved of their dis-

tension. The same events have sometimes arisen from excessive drinking of any liquid, but chiefly where the kidneys and the skin, the natural emunctories for superfluous fluid in the body, have failed in their office. Thus drinking largely of a cold liquid when the body is perspiring and fatigued, weakens the heart's action, and checks the cutaneous and renal secretion; the bloodvessels become filled to tension, and may relieve themselves in dropsical effusions or diarrhœa. External cold sometimes operates in a similar way; it arrests perspiration, and causes internal congestions (§ 292); and if, from previous over-excitement or other defect, the kidneys are unequal to perform what the skin fails to do, general fulness is the result, which tends to issue in some dropsy or flux. The sudden suppression of a cutaneous eruption, or of the discharge from an old ulcer, has sometimes been followed by anasarca, diarrhœa, or bronchial flux (humid asthma). The colliquative sweats of advanced phthisis are of the nature of a flux, by which the bloodvessels, in their obstructed and reduced state, relieve themselves of superfluous liquid. These sweats may generally be stopped by a judicious restriction in liquid food.

375. If we seek instances of local congestion terminating in flux and dropsical effusion, we easily find them in almost every variety of congestion that has been enumerated (§ 288, *et seq.*). In fact, these are the most common causes of partial dropsies.

The adequacy of venous obstruction to produce dropsy, is well illustrated by some experiments of Lower. He tied the jugular veins of a dog, expecting the animal to die of apoplexy; instead of this result, the face and head of the animal became much swelled with œdema. He then tied the ascending cava; ascites and anasarca of the lower extremities were the results. Disease affords numerous examples of dropsy and flux from venous obstruction. Aneurisms of the arch of the aorta, or other tumors, by pressing on the venæ innominatæ, or descending cava, sometimes cause œdema of the face and upper extremities. In a case (under my care) of malignant tumor involving the roots of the lungs, there were hydrothorax, and flux into the bronchial tubes (bronchorrhœa). In advanced pregnancy and ovarian dropsy, the legs swell from pressure of the tumor on the iliac veins. Many instances are recorded in which occlusion of a large vein was followed by dropsy of the part from which the vein proceeded. The ascending cava has been found obliterated in persons who had long been affected with ascites and anasarca of the lower extremities. In the University College collection, there is a drawing of such a case, in which a supplementary circulation had been established by an enormous enlargement of the superficial veins of the abdomen. Dr. Watson relates an instance of the same kind.[1] M. Tonnelé has made some observations which favor the opinion, that chronic hydrocephalus is caused by a partial obliteration of the venous sinuses of the head (§ 267).

But the most common causes of venous obstruction, are certain visceral diseases, and these commonly produce either dropsy or flux. Thus the contractile disease of the liver, cirrhosis, is the most frequent cause

[1] Library of Medicine, Art. "Dropsy," vol. iii.

of simple ascites; and in connection with various functional and structural diseases of the liver, diarrhœa and gastrorrhœa (watery eructations) are apt to occur. Structural disease of the heart, especially if seriously affecting the orifices or valves, commonly causes hydrothorax, bronchial flux (humid asthma), and sometimes general dropsy. Pulmonary congestion from causes impeding the respiration (§ 298), such as spasmodic asthma, emphysema, laryngitis, hanging, and coma, sometimes results in a bronchorrhœa or hydrothorax. In the experiments of Dr. J. Reid, a serous flux into the bronchial tubes ensued after the division of the par vagum, which, by impairing the respiratory action, induces pulmonary congestion.[1]

376. As we found congestion to arise from weakness of the circulation and atony of the vessels (§ 290), so dropsical effusions and fluxes may proceed from the same causes. Thus œdema of the lower extremities is a common sign of extreme weakness; as after severe illness, and towards the fatal termination of many chronic diseases. Colliquative diarrhœa and perspiration (fluxes) sometimes occur under similar circumstances. The œdema and fluxes, which arise from weakness, will be more readily induced by postures which cause gravitative congestion in the affected parts. Thus continued standing causes swelling of the legs, and leucorrhœa, in persons liable to these results of congestion.

377. Fluxes and dropsical effusions sometimes occur after previous excessive excitement of the vessels of a part. Hence œdema after erysipelas, and the infiltration of serum in cavities and textures after excessive excitement of the vessels of these parts, even when no inflammation has been induced. The gleets or fluxes which follow inflammations of the urethra, bronchi, alimentary canal, and vagina, seem to be connected with the same condition of the vessels that sometimes causes congestion (§ 294). Persons who indulge in spirituous liquors often suffer in the morning from waterbrash, for which they find a glass of spirits the best remedy; in this case, however, obstruction in the liver (§§ 56, 371) may also co-operate.

378. Fluxes sometimes arise from the intropulsive operation of cold (§§ 77, 292); thus diarrhœa and catarrhal affections, too transient to be considered inflammatory, are frequently thus induced; and diuresis (flux of urine) is a more healthy example of this effect of cold. It is doubtful whether this operation of cold will suffice to cause dropsy; but it may increase it where it existed previously.

379. The other variety of local hyperæmia, determination of blood (§ 321), may produce fluxes and dropsies. The influence of various stimulants on secreting organs and surfaces, illustrates the production of fluxes in this way (§ 324). Thus, snuff in the nose determines a flow of nasal mucus and of tears; spices in the mouth provoke a discharge from the salivary glands; irritating vapors inhaled cause a flux in the air-tubes; purgative medicines induce a flux from the intestines, &c. In these cases, the irritation is short of inflammation, which, although attended with determination of blood and effusion, comprises farther effects. The fluid thus secreted in these several cases of flux from determination

[1] Edin. Med. and Surg. Journ. vols. xlix. li.

of blood, differs from the products of inflammation; it commonly consists of the natural secretion of the part, diluted with an unusual proportion of water and saline matter from the blood, and the excess of saline matter sometimes gives the secretion an irritating quality, as in the fluid of coryza, bronchorrhœa, and watery diarrhœa.

Other examples of flux may be referred to determination of blood without special irritations; as the leucorrhœa which precedes and follows the menstrual period, the bronchorrhœa or gastrorrhœa in some cases excited by increased action of the heart, and the sweat succeeding to flushes of blood to the head or other parts.

380. Dropsy is less frequently a result of simple determination of blood; because, independently of inflammation, there are few causes for such determination to closed sacs. But probably the dropsy accompanying tubercles in the peritoneum and membranes of the brain, may in some degree be induced by the mechanical irritation of the tubercles causing a flow of blood to the membranes. The sudden mode of attack which tuberculous hydrocephalus sometimes exhibits, seems to countenance this opinion, being attended by the phenomena of determination of blood to the head, described before (§ 323), but here this proceeds to effusion of serum, with its more permanent symptoms. The kinds of dropsy called inflammatory may be included under this head; but we shall shortly see that the determination of blood, or excitement of the circulation, present in such cases, is consequent on an altered condition of the blood itself.

381. As flux and dropsy commonly arise from similar conditions of the vascular system, so they are sometimes found to succeed to one another. Thus Andral mentions a case in which hydrothorax was removed on the occurrence of a profuse flux from the air-passages. Examples are not uncommon of the subsidence of ascites on the occurrence of diarrhœa, or of the supervention of ascites, when a diarrhœa, of long duration, has been suddenly checked. Dr. Watson quotes, from Dr. Farre's lectures, an instance in which hydrocele was removed by violent purging. It is a more familiar fact that the occurrence of dropsy is attended by a marked diminution of the urinary secretion, and that a free flow of this often reduces the dropsy. On a knowledge of the preceding facts may be founded the most effectual treatment of dropsy.

382. Enough has been said to show that flux and dropsy, as well as hemorrhage, are occasional results of hyperæmia in its different varieties. But what are the circumstances which determine the occurrence and kind of these results? In the case of hemorrhage, we found the additional or determining cause to be in the vessels or in the blood (§ 350). So certain conditions of these favor the occurrence of flux and dropsy. An extreme amount of vascular distension will pretty certainly result either in rupture and hemorrhage, or in the exudation of the watery parts of the blood (§§ 305, 340), and the long continuance of congestion or plethora, by making the exhalation predominate over absorption, rarely fails to lead to similar consequences. But in some cases, both dropsical effusions and fluxes take place with a facility disproportioned to the amount of hyperæmia or to its duration; and in these cases the cause may be traced to a generally lax, flabby state of the tonic and contractile fibre

(§ 123), or to a poor watery state of the blood (§ 222), or to both these conditions together. Persons liable to these affections are usually of pale complexion and phlegmatic temperament (§ 40).

The influence which relaxation of the solids has in producing profluvial and hydropic affections, is exhibited in the occurrence of these results in parts after over-excitement (§ 294), where there is no indication of general disease of the blood. But in cases also in which the blood is diseased, there is usually a relaxed state of the vascular fibre; and it is not easy to distinguish the separate influence of these causes. Thus the liability to dropsy and fluxes, after long fevers, defective nourishment (§§ 63, 196), or confinement in impure air, must be attributed to the joint operation of both classes of causes.

383. The conditions of the blood tending to watery effusions, require farther consideration. A poor or watery state of the blood, above noticed, is the most obvious of these; and that this alone is sufficient is plain, from the fact that injecting water in quantities into the veins of an animal, will cause watery effusions or discharges, whilst the injection of blood or serum does not produce this effect. Persons who have lost much blood are liable to become dropsical from the same cause; the bulk of the lost blood is replaced by watery serum absorbed from various sources; and thus the blood is in a diluted state (§ 264). The mode in which a watery blood tends to produce dropsy and flux, is not merely by the greater proneness of thin fluids to transude through the walls of the vessels, but also by the failure and irregular distribution of the force of the circulation. It has been already explained, under the head of anæmia (§ 262), that a scantiness of blood embarrasses the circulation. The structure of the heart, its valves and vessels, is adapted to certain degrees of spissitude and quantity of the blood; and when these vary much from the natural standard, when the blood, instead of being of an unctuous fluidity, is watery and *squashy*, the hydraulic and moving apparatus of the heart and vessels is less capable of effecting its propulsion; and this condition of the blood may thus not only facilitate watery effusions, but promote the congestions and other imperfections in the circulation with which flux and dropsy are commonly connected.

384. Several of the circumstances which induce the thin state of the blood, have been already stated (§§ 222, 249, 382), and in its relations to dropsy, we would more particularly advert to imperfect excretion by the kidneys, liver, and skin, as the most common cause. In various forms of hyperæmia, which lead to dropsy and flux (plethora, congestion, and determination of blood), it will be generally observed that these results ensue in proportion as the excreting organs fail, and that the removal of these results is to be effected chiefly by means which restore or compensate the defective excretion. In many instances, exposure to cold has been followed by dropsy; and at first sight, this might seem to operate merely by checking perspiration, and thus retaining in the vessels water that should be eliminated, and which is then effused within the body. But checked perspiration alone will not cause dropsy; there must be a failure also in the action of the kidneys before this result will ensue. If these act properly, checked perspiration may disorder the circulation, and cause congestions, inflammations, and even

fluxes; but I have never met with a case of dropsy arising from exposure to cold, in which the urine was not diseased, and, in the great majority of instances, albuminous.

The circumstances under which exposure to cold induces dropsy, are such as also impair the action of the kidneys. A man in a fit of intoxication lies for several hours of the night on the cold damp grass; he arises much chilled, has shivering succeeded by fever, and general dropsy ensues; the urine is very scanty, and, on examination, is found to be highly albuminous. The vital properties of the kidneys had been exhausted by the excitement of the stimulant beverage, so that when cold checks the perspiration, and throws the blood on internal organs, the kidneys cannot perform their vicarious action; their vessels become distended with blood, and mechanically exude serum, instead of separating the proper constituents of urine (§ 309); these and the superfluous water accumulate in the blood, and by their quantity and irritating quality cause effusions of serum containing urea in different parts of the body as well as various other functional disorders before noticed (§ 170).

Another instance of a similar kind of general dropsy is that supervening after scarlatina. This has been ascribed by some to a subinflammation of the cellular texture, originating in the eruption; by others to the diseased state of the skin, left by the eruption, suppressing the perspiration. But if either of these were the true cause, the dropsy ought to occur most in the cases in which the eruption is most abundant, which is by no means the fact; nay, I have treated several patients in whom anasarca followed a scarlatina fever, with sore throat, without any rash at all. But in all these cases the urine has been albuminous, which again shows that the diseased action of the kidney is the most essential lesion connected with general dropsy. How scarlatina impairs the function of the kidney is a question too extensive to be discussed here; but I will simply state my belief that it does so by causing in these glands a highly congested state, which injures their secreting power (§ 304), as a parallel effect is observed with regard to the liver in bilious and intermittent fevers. A female under my care with albuminuria, which was almost cured, was attacked with mild scarlet fever; the urine which had been merely hazy by heat and nitric acid, now became highly coagulable, and continued so until the fever declined, when the albumen again gradually decreased.

The general dropsical state occurring towards the fatal termination of structural disease of the heart, I have in several cases found to be connected with albuminuria and slight jaundice, and I have been long in the habit of pointing out these as the most surely fatal complications to which heart diseases naturally tend; their connection has been before noticed (§§ 305, 309).

385. The pathological effects of secretion of serous and scanty urine (oliguria) have been already described (§§ 170, 249), but we must advert to the mode in which it induces dropsy and flux. Where resulting from a suddenly operating cause, such as exposure to cold, or scarlatina, a febrile state is generally present, with a frequent and hard or sharp pulse, heat of skin, thirst, &c. These symptoms occurring in connection with anasarca, have led to the use of the terms inflammatory, febrile,

acute, or active dropsy; and so far as these terms only imply an excited state of the vascular system, they cannot be objected to. But some have employed them to explain the cause of the dropsy, as if this proceeded merely from the excitement or inflammatory condition. That such a condition is present, is obvious not only from the febrile symptoms just mentioned, but also from the buffy state of the blood drawn, and from the dropsical effusions and fluxes being in many cases combined with the symptoms and products of inflammation. Thus the anasarca is often attended with great tenderness, and sometimes with an erysipelatous redness; swellings of the joints frequently have the character of rheumatic inflammation; effusion in the abdomen and pleura is often accompanied by pain or tenderness, and after death, slight deposits of lymph are found in addition to the serum; catarrhal flux from the bronchi, and diarrhœa, are associated with symptoms of more irritation (spasm, constriction, cough, vomiting, pain, and soreness) than occur with simple fluxes.

Now, this inflammatory character may be readily explained, by referring it to the irritating quality of the excrementitious matter which the failing function of the kidneys leaves in the blood. Under such circumstances, urea has been found in the blood, and in various effusions (§ 170), and may be fairly regarded as the *materies morbi* which irritates various parts, and from which, whilst the system seeks to relieve itself (§ 17), excitement and sundry effusions or discharges ensue. In two points, this condition resembles acute rheumatism (§ 351): 1. In the number of parts which may be simultaneously or successively affected. 2. In the want of any constancy in the seat of the affections. Both these points indicate that the cause is not essentially in any part, but in the blood. Another circumstance which approximates these affections to gout and rheumatism, is the nature of the excrementitious matter which accumulates in the blood. In the latter affections, there is good evidence that lithic and lactic acids are the chief ingredients of this matter (§ 256); but I have so commonly found an excess of urea in the urine of patients recovering from rheumatism, and the chief remedies for gout and rheumatism so distinctly increase the elimination of this principle (§ 257), that we can scarcely doubt that, in these affections, urea also is either produced in excess, or insufficiently excreted. The proximity in composition between lithic acid and urea, and the probable conversion of the former into the latter (*Liebig*), should not be forgotten. Both gout and rheumatism, like oliguria, sometimes produce fluxes or catarrhal affections. Lastly, the connection between these affections is apparent from the fact, that rheumatism is frequently complicated with albuminuria (as after scarlatina); and granular degeneration of the kidneys (Bright's disease) is apt to supervene in the most aggravated forms of rheumatism.

386. But, besides the retention of excrementitious matter in the blood, there is a loss of albumen from this fluid. That this loss, by thinning the blood, facilitates dropsical and profluvial effusions, is most probable in all instances; but this seems to be the especial cause of these results in the more chronic cases, and in the most anæmic subjects; for in these, as it has been already stated (§ 264), the blood is thinner and more

watery than in any other disease. Thus in advanced stages of granular degeneration of the kidneys, and sooner in anæmic subjects, almost every congestion, or determination of blood, ends in watery effusion. As the powers of the circulation fail, the effusion is connected chiefly with gravitative congestion (§ 291), and occurs most in the lower extremities; in this respect differing from the dropsy of acute albuminuria, in which the swelling also affects the face, trunk, and upper extremities. This form of dropsy is well entitled to the appellation asthenic, or passive, both from being connected with congestion and weakness of the circulation, and from the poor condition of the blood, and depressed or cachectic state of the functions dependent upon it (§§ 185, 262).

387. From the preceding statements, it may be inferred that acute dropsy arises chiefly from the retention in the blood of excrementitious matter and water which the kidneys fail to eliminate; and that the more chronic or asthenic kinds, although often originating in the same way, are rather dependent on a poor or watery state of the blood, especially deficient in albumen (§ 222). This deficiency in many cases arises both from the continued drain by the loss of serum in the urine, and from the imperfect assimilation and nutrition connected with this state. But we have good evidence that the more chronic and asthenic forms of dropsy may arise from the same state of the blood, independently of disease of the kidneys. Thus Andral and Delafond found dropsy in anæmic sheep in connection with clistomata in the liver, only in those cases in which the albumen of the blood was below the natural standard. So, too, in the human subject; the dropsy induced by very scanty or poor food, or close confinement in unhealthy places or malarious districts, and that supervening in extreme states of debility or cachexia, are probably dependent, not merely on weak or obstructed circulation, but also on an impoverished condition of the blood itself. For the same reason, the various structural diseases which cause congestions, especially those of the heart and liver often do not induce dropsy until the quality of the blood is impaired, either by imperfect excretion or by inadequate nutrition.

388. We have thus traced flux and dropsy, in common, to elements previously considered; hyperæmia, in some of its forms, together with a diseased condition of the blood itself (§ 222), dependent on defective excretion (§§ 249, 250), or defective nutrition or assimilation (§ 268). The latter element, although not essential to the production of fluxes or local dropsies, is the chief cause of general dropsy, and constitutes the dropsical diathesis. If we endeavor farther to distinguish between the pathological causes of flux and dropsy, we find from observation that flux more commonly results from determination of blood or congestion, with a lax state of the solids (§§ 123, 382); whilst dropsy is rather associated with the altered condition of the blood just noticed.

389. The distinction just made between the causes of flux and dropsy, implies that flux is generally a more partial disease than dropsy, many circumstances relaxing the vessels of a part, without affecting the condition of the blood in the whole system. This is especially apt to occur in secreting organs and surfaces, which are, in fact, the common seat

of fluxes. We have before noticed excessive secretion as a primary element of disease (§ 162), but the fluxes which we are now considering consist less in excess of the natural secretion (although this often occurs also), than in the addition of a (watery, saline, and sometimes albuminous fluid derived from the blood, a serosity in fact (§§ 305, 375). The fluids discharged in chronic coryza, bronchorrhœa, gastrorrhœa, and watery diarrhœa are the natural mucus of the respective surfaces, much diluted with a thin serum, the saline matter of which often gives the secretion an irritating property. Sometimes this serous fluid is substituted for the proper secretion, as in the coagulable urine of the more advanced stages of Bright's disease.

The circumstances which commonly induce flux in secreting surfaces, have been already noticed (§ 376, *et seq.*), but after a flux has continued for some time, it is apt to become habitual, apparently through permanent relaxation of these affected vessels. These become so weak that any circumstances disordering the circulation may bring on an attack of the flux. In fact, the flux becomes an outlet for superfluous fluid in the bloodvessels, and for discharges which ought to be evacuated through the kidneys, skin, or bowels.

GENERAL TREATMENT OF FLUX AND DROPSY.

390. As there is much that is common to fluxes and dropsies, we may abridge our notice of the remedial measures to be opposed to them, by first giving the treatment applicable to both, and afterwards specifying that indicated for each class of results.

In so far as fluxes and dropsies depend on plethora, sthenic or asthenic, congestion, in all its varieties, or determination of blood, the remedies for these several morbid elements (§§ 283, *et seq.*, 313, *et seq.*, 342, *et seq.*) must form part of the treatment. So, also, according to the prevalence of these constituent conditions, fluxes or dropsies may be more or less sthenic or active, or asthenic or passive, and more or less constitutional or local ; and the treatment must be varied correspondingly. And according to whether these conditions are tractable or not, fluxes, and dropsies resulting from them, may be more or less difficult to remove, and exhibit many varieties as to duration and disposition to return. Thus fluxes and dropsies which arise from congestions caused by structural disease of the heart or liver, or by tumors compressing veins (§ 375), although often removed for a time, are likely to return ; but those arising from cold (§ 378), weakness (§ 376), previous excitement (§ 377), or functional disorder, may, in many cases, be cured permanently.

391. We have repeatedly stated the circumstances under which vascular congestion or fulness in itself suffices to induce dropsy and flux (§§ 306, 383) ; and under these circumstances, the remedies for congestion and plethora are the first and most important to be used. Thus in dropsy or fluxes suddenly induced by structural disease of the heart and liver, often brought on by cold, over-exertion, or excitement, whilst the condition of the blood has not materially suffered, depletion, general

or local, is advantageously premised before the use of other measures. Then follow remedies which, by increasing the secretions, reduce the remaining congestion and the effusions resulting from them; combinations of mercury or antimony with squill and digitalis are peculiarly serviceable in accomplishing this object. Various other means contribute to the same end, chiefly those which act as evacuants and derivatives. This treatment approaches to the antiphlogistic, as we have already found the nature and products of congestion of high tension, and of sthenic plethora, approximate those of inflammation (§ 307). But in the more peculiar causes of flux and dropsy—those that induce these results with slighter amounts of congestion or disordered circulation (§ 382)—those which constitute the dropsical and profluvial diathesis (§ 388)—we find conditions generally betokening weakness, and requiring a tonic or more supporting plan of treatment; a relaxed state of the solids, and a watery condition of the blood. But even in the treatment of these cases, to derive from the weak or congested parts, and to increase defective excretions, are objects generally to be attempted. Farther details will be better described under separate heads of flux and dropsy.

TREATMENT OF FLUXES.

392. In all cases of flux, it is proper to derive from the affected part, and to promote the natural excretions in other directions, by some or other of the following means: warm bathing, warm clothing, exercise, friction, and stimulant applications to the surface, diaphoretic, diuretic, and aperient medicines. It is also necessary to avoid circumstances which promote congestion or determination of blood in the affected part: such as dependent position, exposure to heat, cold to other parts, too fluid a diet, &c. In addition to these measures, it may be requisite to use others to counteract or remove the irritations or obstructions which the flux causes in the part which it affects. Thus demulcent and narcotic remedies are sometimes useful in catarrh and diarrhœa, to soothe irritation caused by the secreted fluid; at other times, expectorants and purgatives, to promote its expulsion.

393. The farther treatment of fluxes will be guided by the state of the vascular function, whether sthenic or asthenic. As in cases of hemorrhage, so with flux, it is sometimes attended by a hard, frequent pulse, heat of skin, and other signs of fever or of sthenic plethora; here evacuants, antimonials, sedatives, and even bloodletting may be required. In fact, the disease borders on inflammation, and needs a similar treatment. Some cases of flux, of a sthenic character, arise from gouty or rheumatic matter in the blood; here colchicum and alkalies are the proper remedies, as they promote the removal of this matter by the kidneys. Others we have found to be connected with albuminuria (§ 380), and are to be treated as dropsy from that cause. In all these examples of sthenic or active flux, it is neither useful nor safe to attempt hastily to check the discharge by astringent remedies, lest the determination of blood attending it end in a worse result, hemorrhage or inflammation.

394. The majority of fluxes are, however, asthenic, connected with a weak state of the vessels, local or general; and here other remedies are needful. Together with more or less of the general measures above described (§ 392), it is here safe and proper to endeavor to check the profuse exhalation, by astringents, stimulants, and general tonics. Astringent remedies are most effectual by direct application; and their mode of action, by constricting the relaxed vessels (§ 388), is obvious. Thus acetate of lead, sulphate and acetate of zinc, sulphate of copper, nitrate of silver, alum, and some vegetable astringents, are effectual in leucorrhœa and diarrhœa. Some of these remedies seem also to act through the medium of the circulation. Thus sugar of lead, sulphate of zinc, sulphate of copper, and mineral acids, given internally, sometimes distinctly diminish bronchial flux and profuse perspiration, as we have already found they sometimes arrest hemorrhage (§ 367). Some fluxes are remarkably checked by remedies whose operation seems to be rather stimulant than astringent. Thus spices, essential oils, and brandy, sometimes cure pyrosis and diarrhœa; cantharides diminish leucorrhœa; cubebs and copaiba, gonorrhœa; balsams of copaiba and Peru occasionally check bronchorrhœa. It is uncertain how these remedies operate; but it is probably in removing congestions by causing determination of blood, which excites contraction, and improved tone of the capillaries of the part (§ 317). They are most successful in asthenic cases originating from inflammation. Another remedy occasionally useful in controlling fluxes, is opium; its mode of operation is equally uncertain; but it is probably connected with its power to diminish natural secretions (§ 166). Its efficacy is most obvious in diarrhœa and diuresis; and it is sometimes beneficially combined with metallic astringents in bronchial and gastric flux.

The state of the system in persons subject to fluxes is generally one of relaxation, and is therefore benefited by tonic medicines. Some of these have also an astringent property, which peculiarly adapts them for the treatment of asthenic fluxes. Thus the tincture of the sesquichloride of iron is useful in the treatment of leucorrhœa and humoral asthma, attended with much debility; infusion of cusparia in diarrhœa; and bark or quinia with mineral acids, gallic acid and tannin, in various fluxes in very relaxed habits.

For similar reasons, the diet should be as generous as the digestive organs will bear; sometimes including animal food twice a day, and a moderate allowance of some sound fermented liquor. Excess in liquid food should be particularly avoided, especially tea, and warm *slops* generally. Catarrhal colds, which are acute fluxes, I am in the constant habit of curing simply by total abstinence from liquids during two or three days; and although this extent of *dry regimen* is obviously inapplicable to chronic cases, yet moderation in the use of liquids, especially before or during exposure to cold, is an important part of the treatment in all cases. I have known several instances of chronic coryza, bronchorrhœa and diarrhœa kept up, if not brought on, by immoderate indulgence in tea and such liquids. These fluids cause a temporary plethora, which immediately finds vent through the lax vessels of the weak part (§ 389). The propriety of warm clothing, regular exercise, and a brac-

ing, but not too cold an atmosphere, is obvious from the previous considerations.

TREATMENT OF DROPSY.

395. In addition to the means requisite to remove the variety of hyperæmia inducing the dropsy (391), we have to remedy, as far as we can, those conditions of the blood which we have found (§ 384) specially to favor the occurrence of dropsy. Of the causes of these, a failure in the secreting power of the kidneys is the chief; its sign being a scantiness of the urine, a deficiency of the natural constituents of this excretion, sometimes with an accession of albumen. The treatment must, therefore, have regard to the condition of the kidneys, which is the chief cause of this failure in their action, and to the state of the blood and other parts, which is the result of that failure.

We have several times pointed out (§ 309) reasons for supposing a highly congested state of the kidneys to be the first cause of that failure in their function which induces albuminuria and its consequences. The means found most successful in removing dropsy arising from renal disease, correspond well with this view. Thus in acute or inflammatory dropsy, occurring after scarlatina, or exposure to cold (§ 384), bloodletting, especially by cupping to the loins, hydragogue purgatives, and diaphoretics are advantageously used at first; and subsequently some kinds of diuretic medicines, particularly tincture of cantharides, digitalis, and colchicum sometimes restore the natural action of the kidneys. Such measures, if employed at an early period, before the disease in the kidneys has affected the structure, are often completely successful. They fulfil, not only the indication of diminishing the renal congestion, but that also of purifying the blood from excrementitious matter, and in reducing the sundry effusions, local irritations, and disturbance which this matter excites in various parts (§ 385). They cure the dropsy by exciting artificial fluxes (§ 381).

Of the hydragogue purgatives used in the treatment of acute dropsy, I have found cream of tartar in large doses (℥iv. to ℥x, every morning or every alternate morning), and extract of elaterium ($\frac{1}{4}$ gr.), the most effectual. Tartarized antimony, alone, or combined with opium, is the best diaphoretic, and it often relieves the catarrhal symptoms commonly present. Care must be taken not to cause vomiting, to which there is often a natural tendency. Dr. Osborne recommends the vapor-bath, and Dr. Watson the hot-air bath, as means of deriving to the surface, and causing perspiration. After cupping to the loins has been repeated as often as the strength of the patient may indicate, in obstinate cases I have seen much benefit from blisters or other counter-irritants to the loins; and in asthenic cases, which do not bear the loss of blood, large blisters may be used at first with great advantage.

The dropsical effusions are often soon dispersed by the preceding measures; but the proof of the permanent benefit of the treatment is to be looked for in the progressive decrease of albumen, and the increase of urea and lithic acid in the urine. It often happens that, after the full use of depletion, cathartics, and diaphoretics, the condition of the urine

becomes stationary, and does not advance towards a healthy standard. Then the diuretics before named are sometimes very effectual in augmenting the quantity of urine, without increasing the albumen in it; and where this is their first effect, their continuance will often produce a gradual diminution of the albumen. The tincture of cantharides is more powerful than the others in exciting the action of the kidneys; and where it increases the urine, the dose may be augmented from ♏x to ♏xx or ʒss thrice a day; but if the smaller dose do not act as a diuretic, it is not safe to proceed to the larger, nor, in fact, to persist with the medicine; for if it irritates the kidneys without increasing their secretion, it is sure to do harm. We have noticed the same circumstance in the treatment of congestion by stimulants (§ 317); if they fail to remove the congestion, they aggravate the mischief. Digitalis and colchicum are safer diuretics, inasmuch as they are less irritating to the kidneys; but they are also less powerful.

Mercury might be expected to be useful in removing congestion or low inflammation in the kidney, and in restoring its secretion; but it so speedily and severely salivates in such cases, without any equivalent benefit, that it is not generally eligible. The promptitude with which the gums are affected with mercury may be ascribed partly to the facility with which inflammations may be excited in any part (§ 385); and, in some measure, to the failing action of the emunctories of the system permitting the mercury to accumulate more speedily than usual (§ 260). But mercury is peculiarly efficacious in dropsy connected with diseased liver; and, in combination with squill, digitalis, and henbane, or conium, forms the most useful diuretic in all recent cases of dropsy dependent on congestion without disease of the kidneys.

396. We have found (§§ 386, 387) that the asthenic forms of dropsy, and those of the most chronic character, are commonly connected with a watery, non-albuminous state of the blood, and general weakness of the system. To obviate this condition so far as possible by nourishing diet, tonics, and means to increase the strength, becomes here a leading indication. In cases depending on malnutrition or mere debility (§ 387), this tonic-supporting treatment may be sufficient to effect a cure. In the commoner examples of dropsy, rendered asthenic by the long continuance of structural disease of the kidneys, liver, or other organs, the same strengthening and invigorating measures must be more or less combined with means to excite the failing excernent organs, or to produce some compensating discharge. Thus in dropsy from chronic albuminuria, or advanced degrees of granular degeneration of the kidney, the occasional exhibition of hydragogue purgatives and diaphoretics, and of the diuretics before mentioned, is useful, at the same time that bitters with iodide of potassium, or mineral acids, are given to keep up the general strength and powers of nutrition. In the more anæmic cases, iron is often of advantage; but it sometimes proves injurious by impairing the little secreting power remaining in the kidneys, and by rendering the urine more albuminous. Where it has this effect, its use must be abandoned. The preparations of iron that I have found most serviceable in these cases, are the ammonio-citrate in combination with iodide of potassium and the muriated tincture.

Asthenic dropsy arising from diseased liver is sometimes signally relieved by mercurial and diuretic medicines, followed by or even conjoined with columba, bark, and other vegetable tonics. In several cases under my care, ascites, of great extent and long duration, connected with granular degeneration (cirrhosis) of the liver, has been removed, and the patients have been for a time restored to apparent health, by a course of hydragogue doses of cream of tartar every morning, or every other morning, with bark and nourishing diet in the day. Hydragogue purgatives are more directly useful in removing ascites connected with diseased liver, inasmuch as they excite a discharge from the congested vessels themselves, and substitute abdominal flux for abdominal dropsy (§ 381). But they often fail to excite a watery discharge from the intestines, and instead cause much irritation, with tenesmus, and slimy or bloody stools; under these circumstances they must be discontinued; but after blistering the abdomen, or applying leeches to the region of the liver, or to the anus (319), and interposing a gentler but more searching aperient containing mercury, the useful operation of hydragogue purgatives may sometimes be again obtained. Similar means will often facilitate the operation of diuretics. Dr. O'Beirne has argued strongly in favor of bloodletting in dropsy, under the impression that, by relieving the pressure from congested bloodvessels, it enables secreting organs to act. (*Dublin Journ. of Med. Sci.* Nov. 1842.) Like most other writers on dropsy, Dr. O'Beirne does not seem to me sufficiently to regard the mixed character of the disease.

397. The tendency of dropsy connected with diseased heart, kidneys, or liver to recur again and again, and become chronic, renders it needful to vary as much as possible the remedies employed, as well as to use means to support the strength. It is an important point in the treatment of such cases not to exhaust the powers of any secreting organ by two long acting on it, and not to expend the efficacy of any one remedy by too long continuing its use. By employing sometimes diuretics, sometimes purgatives, sometimes diaphoretics, and by aiding each of these by local depletion or derivants, or by stimulants and tonics, according to the temporary prevalence of vascular fulness and excitement, or the converse, much may often be effected to prolong life. It is in the application of these rules to the treatment of prolonged cases, that the skill and resources of the rational practitioner are most tried, and his superiority over the routinist is best proved. It is under these circumstances, too, advantageous to have at command a great variety of medicines, particularly diuretics, and to alternate them or vary them in order to increase or maintain their effect. Those that I have found most effectual are—combinations of mercury, squill, digitalis, and conium (not in acute albuminuria); combinations of decoction of broom, or pyrola umbellata, with nitrate and acetate of potass; the juice or extract of taraxacum, with the same salts or bitartrate of potass, or with nitric acid (particularly in hepatic disease); infusion or tincture of digitalis, with iodide of potassium, and bitartrate of potass (in dropsy after scarlatina); the same, together with increasing doses of tincture of cantharides (in asthenic cases of albuminuria, after cupping to the loins and hydragogue purgatives); ammonio-tartrate and ammonio-citrate of iron in Seltzer water

(in asthenic dropsy); gin in cream of tartar beverage (imperial); compound spirit of juniper, spirit of nitric ether, with various others (in cases of debility). The latter stimulant diuretics have disappointed me more than any of the rest.

398. When dropsical swellings have reached a certain amount of tension, diuretic and other remedies produce little or no effect on them. The veins and lymphatics, whose office it is to remove these swellings, are too much compressed to be capable of absorbing. In the case of ascites, this pressure impedes the circulation through the kidneys and intestines, and their secretions are proportionally reduced (§ 159. Extensive hydrothorax, and even ascites, in a similar way embarrass the functions of the lungs and heart. Anasarca, in its extreme degrees, sometimes impedes the circulation in the vessels of the lower extremities, so far, as not only to prevent absorption, but even to cause the death of the parts; hence gangrene of the legs is a common termination of incurable dropsy. The gangrene is commonly preceded by an erysipelatous kind of inflammation, which often seems to originate in some accidental scratch, or from the irritation of mechanical tension, or of the quality of the effused fluid.

Now, in all these cases, the great expedient is to give exit to a portion of the fluid, by tapping or puncturing the parts which contain it. Thus the abdomen is tapped for ascites; the chest for hydrothorax; the scrotum for hydrocele; the brain for hydrocephalus; ovarian and other cysts, when they attain a large size; and the legs are acupunctured for anasarca. The relief afforded by these means is sometimes very remarkable, even when much fluid is left unremoved. In fact, the great utility of these operations seems to consist in the removal of an amount of pressure and distension that was seriously impeding the functions of the several parts. Accordingly we find, after these operations, not only a great mitigation of suffering, but a restoration of the functions of circulation, secretion, respiration, &c., which before were mechanically obstructed. After paracentesis, diuretic and other remedies regain their power, and contribute to reduce the remaining effusion; and the secretions being free, the patient is able to bear nourishing food and strengthening remedies, which previously would have increased the excitement and oppression.

The usual indications for the use of these surgical resources are, an amount of dropsical effusion which seriously injures the functions of circulation, secretion, or respiration, other remedies having failed to give relief. Under such circumstances the operation should not be delayed. In puncturing the legs for anasarca, it is proper to bear in mind the tendency to low inflammation and gangrene; and to avoid this, the skin and flesh should be injured as little as possible; numerous punctures should be made with a fine needle, but not too close together; and inasmuch as there is more tendency to this result where the circulation is weakest and most remote from the heart, it is better to avoid puncturing below the knees.

Farther details on these subjects properly belong to special pathology, and would be out of place here.

SECTION VII.

LOCAL HYPERÆMIA. EXCESS OF BLOOD IN A PART.

III. WITH MOTION PARTLY INCREASED, PARTLY DIMINISHED= INFLAMMATION.

DEFINITIONS.

399. The morbid conditions connected with the quantity and motion of the blood hitherto described, have been pretty distinctly defined; and we have been able to refer many phenomena of disease to them. We now come to one, the name of which is very familiar, and its frequency gives it so high an importance that it has always attracted the first attention of pathologists; but although so commonly occurring, it is much more complicated in its nature than any of the morbid elements previously considered; in fact, it may be said almost to comprehend them all, besides being a still farther deviation from the natural condition.

The terms *inflammation*, *phlegmasia*, and *phlogosis* have been used, from a very remote period, to denote figuratively the heat, redness, and burning and painful sensations which commonly exist in inflamed parts. The occurrence of inflammation is so common, and its more prominent symptoms so familiar, that it has long been distinguished as a chief element of disease; in fact it has, in a measure, engrossed the attention of pathologists so entirely, that other important elements have been almost overlooked; and this oversight has not only retarded the advancement of our knowledge with regard to these other elements, but it has rendered the subject of inflammation itself less intelligible, by excluding the consideration of some of its component parts, and by keeping it in all its complexity and remoteness from the normal conditions of function and structure. We shall find that an acquaintance with the ultimate and proximate elements of disease, already considered in this work, is essential to the proper understanding of the nature of inflammation; for these form the connecting link between the natural properties of living textures, and their extreme variation in the state of inflammation. The pathological definition given above to distinguish inflammation from the other varieties of hyperæmia—*too much blood in a part with motion* (of that blood) *partly increased partly diminished*—is easily demonstrated in the strong pulse of arteries leading to an inflamed part, and in the stagnation of much blood in the part.

400. But besides this pathological definition, its outward characters may be briefly defined in the four signs, which from the time of Celsus have been considered distinctive of inflammation, *redness*, *heat*, *pain*, and *swelling*. These signs are sometimes produced by congestion (§ 303), and by determination of blood (§ 333, &c.); but in a degree less

marked, and for a time less continued, than in inflammation; and although there are cases and forms of inflammation in which it is not possible to detect all these marks, they may still be said to constitute its most general character. In common with other varieties of local hyperæmia, inflammation owes the sign of redness to the excess of blood in the part; but we shall find that this redness is heightened by a peculiar concentration of the particles in the inflamed vessels, which is also the cause of the peculiar results of the process. As in determination of blood, the heat and pain are in part due to the increased motion of the blood; but in inflammation, they are exaggerated by the motion being opposed to obstruction. As with other forms of hyperæmia, the swelling arises partly from the over-distension of the bloodvessels, and partly from effusions from them; but in these effusions, inflammation differs from congestion and simple determination, departing still farther than these from the natural quantity and quality of the effused matters.

CAUSES OF INFLAMMATION, AND THEIR MODE OF OPERATION.

401. *Predisposition* to inflammation has been already noticed under the head of predisposing causes of disease (chap. i. sect. 2). The circumstances which render the body liable to inflammation, are those which especially affect the vascular system, whether these circumstances be the result of original conformation, as the sanguine temperament (§ 38); or whether they be the effect of previous disease (§ 31), of present disease (§ 34), or of external or internal causes in actual operation (§ 20, *et seq.* 30). Inasmuch as various circumstances, external or internal, tend, generally or locally, to impair the healthy tone and balance of the vascular system (§ 123), whilst muscular irritability (§ 112) and the quantity of the blood are not proportionately reduced (§ 195), so far they predispose to inflammation. Accordingly, we find persons prone to inflammation to be those whose circulation has been weakened or irregularly excited by previous disease, fatigue, confinement, impure air, or improper nourishment. But it will presently appear that predisposition to inflammation differs according to the nature of the cause which excites inflammation; those most subject to inflammation from causes acting generally, suffering less than others from causes which act only locally. Thus, a depressed state of the whole vascular system favors the production of inflammation from causes acting generally (such as cold); whereas, an excited state of the vascular system favors the development of inflammation from local irritation.

402. The concluding part of the last paragraph prepares us to divide the *exciting causes* of inflammation into those which act locally on the part which inflames, and those which act more generally on other parts. The operation of the first class is direct; that of the second is indirect; therefore, less certain, and more dependent on predisposition.

The *local* exciting causes of inflammation comprehend *irritants, mechanical, chemical*, and *vital*. A grain of sand in the eye, a thorn in the true skin, and a bruise or wound in the flesh are examples of mechanical irritants, or sources of irritation. Chemical irritants are those

which operate on living matter by strong chemical affinity, tending to alter or decompose it (§ 53); such are heat, strong acids, and alkalies, various corrosive salts, chlorine, iodine, &c.; these act also on dead textures. Vital irritants are various agents whose irritating operation is not referable to any known chemical property, nor do they act on dead animal textures; of this kind are cantharides, mustard, capsicum, and essential oils. In this last class must be included various animal and vegetable irritant poisons; such as that of smallpox, and the venom of some noxious animals and plants, which act as local irritants, besides otherwise affecting the system. Various noxious matters sometimes generated in the living or recently dead body, are also capable of exciting inflammation when applied to an abraded surface (§ 258). Nay, the natural excretions of the body become most acrid irritants, when brought into contact with serous membranes; thus urine, feces, and bile, effused in serous membranes, even in the smallest quantities, produce intense irritation and inflammation.

Irritation and inflammation are sometimes caused by excrementitious matter retained in the blood, where the functions of the excernent organs are impaired (§§ 249, 251, 254). Local inflammations are also excited by certain poisons received into the system; thus arsenic, even when applied to a wound, causes inflammation of the stomach and intestines; mercury excites inflammation of the gums; the poisons of smallpox, scarlatina, and measles, inflame the skin, throat, and air-passages; that of syphilis, the periosteum, throat, skin, iris, &c. In these cases, there can be little doubt that inflammation is excited by the actual presence of the peculiar irritating matter in the parts which inflame, conveyed there in the blood; and it is a leading character in the operation of these irritants which are conveyed through the blood, that it affects several parts, or a considerable portion of the body at once; and frequently, the two sides of the body in a similar manner. This is observed in the eruptions of exanthematous and other skin diseases, in rheumatism, in syphilitic nodes, &c. (§ 259).

403. The second class of causes exciting inflammation, those which operate indirectly, are of very common occurrence; and, although comprising fewer agents, they as frequently produce diseases as the more direct causes of irritation. They include those which first produce congestion, which, on the occurrence of subsequent reaction, is converted into inflammation. The most common of these causes is cold, which, both by its local operation (§ 76), and by its more general application (§ 77), may produce congestions (§§ 292, 296), which may pass into inflammation. Malaria, and the influences which induce continued and eruptive fevers, as they produce congestions (§ 293), so they often lay the foundation of inflammations, which complicate the febrile affections excited by these causes. Inflammations sometimes arise out of the congestions caused by venous obstruction (§ 289) and gravitation. Thus pneumonia (with hepatization, and sometimes suppuration) frequently occurs in connection with disease of the heart, impeding the circulation; in adynamic fevers, and in the sinking which precedes death (§ 290). The congestions of the lungs, brain, and mucous membranes, that result from the application of various asphyxiating causes (§ 298), sometimes

end in inflammations, which become a chief source of danger after the restoration of the respiration (§§ 235, 243).

404. Suppression of natural or habitual discharges, especially the catamenia, the sudden drying up of ulcers, and repulsion of cutaneous eruptions (§ 69), are recognized as causes of inflammation (§ 67). So far as the inflammation excited by these causes is in, or contiguous to, the parts previously affected, local irritation may have a share in producing it; but where it is in distant parts, it probably results from a congestion or local determination of blood, which belongs to the second class of causes just specified. Very probably some of these causes of inflammation have a twofold operation, that just specified (producing a local fulness), and that of local irritation by morbid matters introduced into the circulating mass of blood. Thus the visceral inflammations arising on the sudden healing of a suppurating wound may be promoted by local congestions resulting from the cessation of the purulent discharge; but their circumscribed character, and the uniform event to which they tend (suppuration), seem to indicate a morbid matter in the circulating blood, as the exciting cause of these inflammations, and microscopical researches have confirmed this inference. The same remark will apply to the inflammations of the skin, fauces, and mucous membranes in scarlatina, measles, and smallpox, the follicular enteritis of typhus,[1] and the visceral complications of erysipelas, and other specific febrile affections. In all these, besides a general tendency to internal congestions, we seem to trace the irritating operation of a morbid poison on particular parts.

405. We have noticed that sthenic hemorrhages (§ 363) and fluxes (§ 393), if too speedily checked without sufficient reduction of the circulation, are apt to pass into inflammation. So likewise determination of blood, if it be long continued, may issue in inflammation (§ 340). The causes which excite determination of blood, when applied in a greater degree, or for a longer time, excite inflammation.

406. Before we proceed to examine into the nature of inflammation, we may properly inquire what is the mode of the operation of its causes. It is generally assumed that the first movement of inflammation, as of all pathological processes, is in the nerves; but this is by no means proved. That some causes of inflammation (irritants) operate first on

[1] I have observed an extraordinary development and inflammation of the isolated and grouped glands of the intestines in the bodies of persons poisoned with arsenic. Their enlargement in epidemic cholera, and in the severe form of sporadic cholera, diarrhœa, and dysentery, caused by putrid effluvia, is well known. Are these glands excretory organs for the elimination of poisonous or noxious matters from the system? and in typhus fever, do they become inflamed and ulcerated by the continued operation of the poison in the exercise of this function? The favorable influence of moderate diarrhœa in fever, the uncommon fetor of the stools, the general relation between the duration of the fever and the affection of these follicles, the salutary operation of mild mercurial remedies, which promote their secretion, and other facts that might be adduced, give so much countenance to this question, as to make it worthy of attention.

The preceding surmise, put forth in the first edition of this work, has received corroboration from numerous facts which I have subsequently observed, and it seems to me to indicate the true cause of the intestinal complication in fevers and other diseases induced by a morbid poison in the system. Dr. Carpenter has recently advocated this opinion, and farther applied it to account for the fetid and colliquative diarrhœa which often occurs in states of much depression.—(*Human Physiology*, [p. 637, 5th Am. Ed.])

the nerves, is probable from the following considerations: 1. Their action on the sensitive nerves is felt long before inflammation begins; thus the prick of a thorn in the skin, the smarting of caustic on a wound, the pain of the sting of an insect, are felt instantaneously; there is first nervous irritation; inflammation follows after. 2. The irritation is sometimes transferred to other parts by sympathy, of which nerves are the channels; thus strong irritants in the nostrils may cause inflammation of the conjunctiva, a carious tooth or a diseased bone may irritate and inflame parts which are not contiguous to it. 3. An injury to a nerve is sometimes followed by inflammation in parts connected with this nerve. Thus paralyzed limbs are liable to become inflamed. Lallemand relates a case in which a ligature, involving the right brachial plexus, was followed by inflammation and suppuration in the opposite hemisphere of the brain.

407. On the other hand, the following arguments may be adduced to show that the nerves are not essentially the seat of the first part of the process of inflammation. 1. Some of the causes of inflammation (the majority of those inducing internal inflammation) produce on the nerves or nervous system no known primary effect which resembles that of other causes of inflammation (irritants); thus inflammations excited by cold are often preceded by no marked nervous disturbance; whereas the strongest impressions of cold on this system are frequently not followed by inflammation (§ 77). 2. Inflammations often originate in congestions (§ 403), and in the sudden suppression of hemorrhages and other discharges (§ 405), without the occurrence of any symptoms referable to the nerves; hence inflammations thus arising may escape detection, and are called *latent*. 3. Persons in whom nervous properties are most developed (§§ 126, 152, 156) are not those most susceptible of inflammation; and all varieties of nervous excitement are sometimes manifest in the highest degree without any inflammation ensuing. Even where pain and other nervous symptoms are excessive, and are the result of mechanical or chemical injuries (such as crushed limbs, extensive burns, &c.), inflammation sometimes does not follow; and this has led surgeons long to distinguish between irritation and inflammation. 4. Inflammation readily occurs in parts the nerves of which are paralyzed or have been divided.[1]

408. Seeing, then, that inflammation is frequently excited without any obvious affection of the nerves, and is often not excited when nervous irritation is most intense, it may fairly be inferred that an impression on the nerves is not an essential part of the first process of inflammation. That the nerves are concerned in many ulterior phenomena of inflammation, and in its extension, is fully admitted; and in the case of excitement of inflammation by irritation, the primary operation of the exciting cause on the nerves has been already pointed out (§ 406). So

[1] It is maintained by Dr. Copland and others that, in these cases, branches of the ganglionic system distributed on the coats of the bloodvessels are the first subjects of excitement. This hypothesis gives no aid in the explanation of the phenomena, because nothing is definitely known as to the properties communicated by ganglionic nerves. Before the "influence of the ganglionic system" can be employed as an element in pathology, its existence must be proved, and its properties defined in physiology; this has not been done.

far as is known, the bloodvessels are the essential seat of the whole process of inflammation; and although some of the exciting causes of inflammation (§ 402, irritants) act on the nerves as well, yet others (§ 403, as cold) operate chiefly and essentially only on the bloodvessels. Hence we find that the causes predisposing to inflammation (§ 401) are circumstances chiefly affecting the vascular system. A review of the exciting causes of inflammation (§§ 402, 405) will show that in their mode of operation on the bloodvessels they may be divided into two classes: 1, those that cause determination of blood (§§ 322–324); and, 2, those that produce congestion (§§ 290–299). The former class comprehends all irritants (§ 402); the latter class includes cold and other agents, which directly produce congestion (§§ 403, 405). We have several times had occasion to mention that determination of blood, when exceeding certain limits, is apt to pass into inflammation (§ 340); and that local congestions are liable to be converted into inflammation (§§ 292, 293, 306).

PHENOMENA AND NATURE OF INFLAMMATION.

409. Having noticed the causes of inflammation, and traced their essential operation to be on the bloodvessels and their contents, we have next to inquire what is the character of their operation on the vessels, and what phenomena it develops.

That the bloodvessels are enlarged in an inflamed part is very obvious from the increased redness manifest to the naked eye. But in what respect does inflammation differ from congestion, in which also the vessels are enlarged? It differs not only in the accompanying symptoms and in its products, but also in the observed condition of the vessels of the part. Thus, besides greater pain and heat in an inflamed part, and earlier and more abundant effusions into or from it, the more florid hue of redness, the strong beating of the arteries leading to the part, and augmented quantity of blood flowing from its veins, clearly indicate that there is increased motion of the blood, instead of diminished motion, as in congestion (§ 287).

Common observation of the pulse of arteries leading to inflamed parts would suffice to show that there is determination of blood to them; and some experiments, performed by Dr. Alison and others, have directly proved that these arteries are enlarged.[1] It was found that the arteries leading to an inflamed limb in a horse were considerably larger than those of the sound limb. John Hunter had arrived at the same conclusion from experiments on the ears of a rabbit. Now, this enlargement has been before traced to diminished tonicity in the affected arteries, and this was found to be the chief instrument in causing determination of blood (§§ 326, 327).

That the motion of the blood is increased through an inflamed part, is distinctly proved by the observation of Mr. Lawrence; venesection being performed at the same time, and in the same manner, in both arms of a

[1] Trans. of British Association, 1835.

patient who had an inflammation in one hand, a much greater quantity of blood flowed from the vein of the arm of the inflamed hand than from that of the other arm.

410. It is certain, both from the preceding facts, and from direct observation under the microscope, that determination of blood is present in inflammation. The vessels in the vicinity of the inflamed part are the channels of an increased flow, there being a flux of blood to the whole inflamed part, and through some of its vessels. But if this were all, there would be no distinction between determination of blood and inflammation; yet the greater redness and swelling, and peculiar character of the effusion, point out that inflammation is not mere determination. Microscopic research has established one great point of difference. The observations of Thomson, Hastings, Kaltenbrunner, and Marshall Hall, have long clearly proved that there is more or less *obstruction* to the passage of the blood in the vessels most inflamed. Thus in the frog's web, when a part inflames from local irritation, the blood is seen to move more slowly in the part most irritated, and gradually accumulating in the vessels, renders them larger, redder, and more tortuous, until the motion ceases altogether in them, whilst neighboring vessels are still the channel of an increased current. A chief point, then, in which inflammation differs from determination of blood, is in the retarded or arrested flow of blood in some of the vessels. This answers to the definition which we have given of inflammation; *too much blood in a part, with motion (of that blood) partly increased, partly diminished* (§ 399).

411. The question now naturally arises. What is the cause of the obstructed or retarded flow of blood through an inflamed part? This has ever been the chief difficulty in the pathology of inflammation; and it is especially to solve this that various hypotheses have been framed. Thus Cullen supposed a spasm of the extreme vessels to be the cause of obstruction, and therefore the proximate cause (§ 13) of inflammation. Dr. Wilson Philip ascribes the same obstruction to a weakness of the capillaries, which he presumes to incapacitate these vessels from transmitting the blood. John Hunter considered that there is something more active and vital in the enlargement of inflamed vessels, and he applied to it the term "active dilatation." The analogous expressions, "vital turgescence," "turgor vitalis," "inflammatory erection," used by Kaltenbrunner and other German writers, imply a similar notion.

The hypothesis of Cullen is quite inconsistent with direct observation, the extreme vessels being seen, under the microscope, to be in a state of dilatation, not of spasm. This observation corresponds better with the idea of Dr. W. Philip, which was, indeed, founded upon it; but it has been objected by Dr. Marshall Hall, and others, that the capillaries, by their contraction, do not aid in the circulation of the blood, and that their "debility," therefore, cannot be a sufficient cause for interrupted passage of blood through them. The words used by Hunter scarcely convey any explanatory meaning. They may be interpreted to assume the existence of a self-expansive power in the vessels, which power is supposed to act in inflammation, as well as in natural formative or plastic processes in the animal body. But the existence of such a power is quite at variance with all that is known of animal physics. A part may

be expanded by elasticity, or by the injection or retention of fluid in it, but no direct vital expansile power has been ever proved to exist. The apparently active expansion of the heart in its diastole, may be ascribed to the natural elasticity of the organ, and the increasing weight of its contents, suddenly enlarging its size on the cessation of its antagonizing systole; neither its structure nor its mode of action countenances the notion of a vital dilating power.

412. Haller, and some of his followers, ascribed the circulation of the blood, in part, to certain supposed properties of vital attraction and repulsion, by which the blood is drawn into, or repelled from, particular parts, independently of all motion of the living solids. These opinions have been recently advocated, with much ability, by Dr. Alison and some of his followers, who consider changes in these assumed vital attractions and repulsions, to be the chief elements in the process of inflammation, as well as in other pathological conditions in which the blood and its vessels are mainly concerned.[1] This hypothesis needs the most ample proof before it can be received. It assumes the existence, in the fluids as well as in the solids of the living body, of properties as

[1] See Alison's *Outlines of Pathology and Practice of Medicine.* Several of Dr. Alison's arguments in favor of the existence of "vital attractions and repulsions," are founded on certain physiological facts, which he considers inexplicable in any other view. It belongs properly to works on physiology to discuss these matters; but I must own that none of these arguments seem to me to be satisfactory. The motion of the sap in the chara and other vegetables, may be well explained on the principle of exosmosis and endosmosis. A fluid of lower density (water), physically tends to penetrate and pass into membranous tubes, containing a liquid of greater density (sap); that which begins a flow into the tubes, may sustain it in continued current through them, so long as the difference in density subsists between the water and sap. A similar principle doubtless aids, in many cases, the motion of fluids in the animal body; but many motions of fluids observed in animals (as in the air-tubes, genito-urinary passages, &c.) have been traced to the vibrations of cilia, and are no proof of the existence of vital attractions and repulsions.

It is said, that, when an artery is tied, the blood ceases to run in the open part of it, and passes away by adjoining branches, which become enlarged in proportion, whilst the tied portion becomes empty. It has been supposed that the blood here spontaneously leaves the part of the artery through which there is no passage. I demur to the correctness of the statement, and still more to the explanation. Every one who has witnessed great surgical operations, must have noticed the strong pulsation above the ligature of tied arteries; and the occasional occurrence of secondary hemorrhage shows that the blood has no inherent disposition to pass in a new direction. No doubt, the artery ceases to receive blood into its tied portion; but this is because either a coagulum is formed where a current cannot pass, or the tonicity of this portion effects the contraction of the tube, the force of the circulation being diverted into the contiguous enlarged branches. Here is no proof of any self-motory and self-directing power in the blood. I have before stated, that all my own microscopic observations have failed to detect in the blood any spontaneous motions, independent of contractions of the solids, or of currents, caused by ciliary motion, exosmosis and endosmosis, and such physical influences. The oscillatory motion said to have been seen by Haller and Kaltenbrunner in the small bloodvessels of inflamed parts, "even after the heart is at rest," may, perhaps, be ascribed to the tonic contraction of the arteries, which, although gradual in itself, is often seen to act by jerks on partially obstructed vessels. A similar oscillatory movement is sometimes communicated to capillary vessels by the quivering contraction of adjoining muscles. Another observation of Haller mentioned by Dr. Alison, that of "blood escaping from vessels between the layers of a living membrane, and nevertheless pursuing its course in a regular stream for a time, even against the influence of gravity," may be fairly referred to the *vis á tergo* from the open vessel. In the fluids of such a nicely adjusted hydraulic apparatus as the vascular system of animals, and even vegetables, it is surprising how readily motions may be produced by various physical causes; and when these motions are magnified by the microscope, it is not wonderful that they should have been mistaken for vital movements of the fluids themselves.

distinctive, and as peculiarly vital, as that of contractility or sensibility. It ascribes to these fluids and solids powers of attraction and repulsion at *sensible* distances, like the attractions and repulsions of electricity, magnetism, or gravitation, yet distinct from all these, and sometimes opposed to them. It attributes to the living body a new physical power, and almost a discerning intelligence in the exercise of that power. Now, before the existence of such a power can be admitted, it must be proved that the phenomena of living structures are not, and cannot be, explained through any known vital or physical agencies. We have already adduced and referred to arguments and observations, to show that the *known* physical and vital properties of the living body will account for the chief phenomena of health and disease, without assuming the existence of any forces of a mysterious character; and we have now to consider whether the same thing may be done with regard to inflammation. If we succeed in explaining the nature and effects of inflammation by a reference to ascertained properties, it will be needless and unphilosophical to assume the existence of others, which are mysterious and unknown. We do not pretend to propose these explanations as complete or certain, but as the best that we can devise in the present state of science, and the most consistent with well-established facts; and it is very satisfactory to observe that the discoveries in chemical physiology made since the first edition of this work was written, so far from invalidating these views on the nature of inflammation and its results, go far to confirm and extend them.

413. We have before stated (§ 408) that inflammation may originate either in determination of blood, or in congestion; and we now proceed to show that inflammation essentially comprises both these morbid elements. The mode in which the process of inflammation has been chiefly studied, is by observing under the microscope the effect of irritants on the frog's web. It must be remembered, however, that this is only one mode in which inflammation may begin, and we shall afterwards find that cold-blooded animals fail to show some of the most remarkable results of inflammation.

The effect of weak irritants on the vessels of the frog's web has been described before (§§ 294, 326). We then found that irritation may cause first determination of blood, then congestion, these results being dependent on an enlargement respectively of the arteries and of the veins and capillaries. But if a strong irritant (as a grain of capsicum, or a minute globule of essential oil[1]) be applied to the web of a frog, all the blood-vessels speedily become enlarged; those most irritated are very large and red, and the blood in them is stagnant and coagulated; contiguous vessels are also very large, but less red, and the motion of the blood in them is slow, and often in pulses or oscillations; whilst in vessels beyond, the enlargement of the capillaries is less considerable, but that of the arteries is obvious, and the current of blood is very rapid.

Now, it is obviously the stagnation or tardy motion of the blood in the most enlarged capillaries, in the midst of surrounding increased flow, that most characterizes inflammation; and we have still to inquire what

[1] These are preferred because they produce no chemical change in the parts.

is the cause of the stagnation. This cause must be either in the vessels, or in their blood, or in both. The latter we shall find to be the true case.

414. We have already pointed out (§ 300) that atony and flaccidity of bloodvessels may become a cause of impediment to a current through them, not by preventing these vessels from actively contracting on their contents (for they have no such power), but by removing that tone by which the vessels maintain the caliber and the tension best calculated to transmit onwards the force of the current. Vessels thus weak and inelastic, instead of equably conveying the current, become distended, lengthened, and tortuous in receiving it; and by their very mass, as well as by their inelasticity, they partly break the force of the current, and partly turn it into other channels. The mode in which this results in inflammation will be better understood, if we review other local modifications of the circulation in comparison with it.

In determination of blood, the arteries are enlarged, and so are the capillaries in due proportion; the circulation is therefore equally increased. In congestion, the capillaries are enlarged, without any increase of the arteries; the motion is therefore impaired; but still, being gentle, it may diffuse itself through the mass, which moves slowly. But if to congested capillaries there be added the increased and abrupt force of the current from enlarged arteries, or if to determination of blood (enlarged arteries) (§ 326) an atonic congestion of the capillaries be joined, the propulsive power of the current will be impaired. As in the experiment with the intestine (§ 300), the blood will pulsate or oscillate in the distended vessels rather than pass through them; and the main current will pass through collateral anastomosing channels, which become the seat of simple determination or increased flow. This is just the state of things in the incipient stage of inflammation; and if either the capillaries do not speedily recover their tone, or the arteries do not contract, the blood in part becomes stagnant, its particles adhere to each other, and to the walls of the vessel, and the obstruction is confirmed. The arterial portions of some of the obstructed capillaries are still open, and exposed to pulsative force from the supplying arteries, which continues to strain their coats, and cause an oscillatory motion of their blood-particles, but no passage through them. Such are the phenomena which we see under the microscope.

It may, then, be fairly inferred, that one cause of the stagnation or retardation of the blood in an inflamed part, is a weak inelastic state of the capillary vessels;[1] such, in fact, as exists in cases of atonic congestion; and on referring to the causes of inflammation (§ 404), it may be perceived that many of them act by first producing congestion. Nay,

[1] It may, perhaps, be objected, that I have supposed a similar atonic state of the arteries to be the cause of an increased flow through them, and to be the physical cause of determination of blood. But this is no objection. The arteries, as compared with the capillaries, are few in number; their current is rapid; they are exposed to the pressure of a *vis à tergo*, which maintains the velocity of their current, whatsoever may be their caliber; when their coats lose some of their tone, this pressure of blood into them stretches them to tension, and they thus admit an augmented force and volume. In capillaries, on the other hand, the current is so much subdivided and straitened that it is easily disturbed, and the motion, naturally tardy, is readily arrested.

we have found (§ 294) that even irritants, in some measure, operate in the same way. "The continued application of stimuli to a part is sometimes followed not by inflammation, but by congestion. This especially happens in the liver, a chiefly venous organ; but it occurs also in other parts. It might be supposed that the stimuli act by exhausting the contractility of the small vessels, and thus leaving them weakened and distended by their contents . . . .
But on the application of a strong stimulant, such as a minute particle of essential oil, the previous arterial contraction is not apparent, and the enlargement is speedy and obvious, causing extreme rapidity of motion and enlargement in all the vessels. In a few minutes, the size of the arteries begins to diminish, and with it the motion in the capillaries beyond them. Many of the capillaries still retain their enlarged dimensions; in them the motion is most sluggish, and, in some parts, ceases altogether."[1]

415. But it is very certain that the obstruction, and much of the other features of inflammation, are generally dependent on changes which take place in the blood within the inflamed vessels. J. Hunter did not overlook this; and, besides describing the coagulation of the blood in the most inflamed vessels, he mentions the adhesion of fibrine to their interior. The coagulation of the blood in the inflamed vessels was also noticed by Gendrin and others; and Dr. Marshall Hall attributed the obstruction of the vessels in inflammation to the adhesion of blood-globules to the walls of the vessels. It appeared to me that microscopic observation ought to be directed to this point more specially than had hitherto been done; and in 1841, I made many careful examinations of the early stage of inflammation in the frog's web. Some of the results were published in the *Medical Gazette* of July of that year; and as they have been confirmed by several other observers, it may be proper to describe them.

Poisseuille, in his observations with regard to the motionless layer of serum which intervenes between the moving blood and the walls of blood-vessels, had noticed that the blood-particles sometimes get into this still layer, and either remain fixed there, or move onwards more slowly than the rest of the blood. In repeating this observation, Mr. Toynbee and myself remarked, that it was not the red particle, or elliptical blood-disks, that thus adhered to, or slowly rolled along the sides of the vessels, but the white or colorless globules (§ 212), called by Müller, lymph-globules. (The following description is taken from my *Gulstonian Lectures*, of 1841): "I have never seen a solitary elliptical disk adhering to the sides of a vessel; and whenever one was arrested in its course, it was from its becoming hitched by one or more of the adherent round globules. But what appeared to me most remarkable with regard to these white globules, was the great difference in their number under different circumstances. In young frogs, and in those much subjected to experiment, they are always present in great numbers; but in healthy adult frogs placed under the microscope with as little handling of the web as possible, there were comparatively few to be seen. I have watched, for

[1] Extracted from the Author's Gulstonian Lectures for 1841, *Med. Gaz.* July 16, 1841.

ten minutes at a time, without seeing one; the motionless layer was very thin but clear, and all the blood-particles in the larger vessels seemed to move at the same rate of speed." It is under these circumstances that the effect of irritation or mechanical injury was best seen. "By pressure of the finger on the web, partial stagnation was produced in many of the vessels; and when this yielded to the returning current the walls of the vessel were seen studded with the white globules; whilst many others of the same kind rolled over them slowly in the direction of the current. I have before mentioned (§ 294), that a similar result ensued, after the web had been stimulated by capsicum or an aromatic water. Even in the rapid flow of blood following these applications, minute globules could be seen creeping slowly along the transparent outline of the larger vessels; and as the arteries contracted, and the flow through the other vessels became less rapid, the number of these globules increased, their motion became slower, and many adhered to the sides of the vessels. If the stimulus used was rather strong or long applied, the number of sticking globules was so great as to prevent the red particles from passing; and these, becoming impacted in increased numbers, gave to the obstructed vessels a uniform and deeper red color. When the stimulation was moderate, and equally applied to the web, the stagnation usually took place first in some of those anastomosing veins in which the current is naturally slow, and varying in direction; but when a stronger stimulus (as an essential oil) was used, the stagnation speedily ensued at the point of its application; in fact, unless very minute quantities were employed, the stagnation was almost immediate and extensive."[1]

416. I have varied these observations in a great many ways, and have

[1] *Med. Gaz.* July 23, 1841. It was not until after these observations were made that I became acquainted with similar ones, previously published by Mr. Addison, of Great Malvern, in the *Med. Gaz.* of Jan. 29 of the same year. The following description is given by Mr. Addison: "In the frog's web, two days after the application of *salt*, in some of the larger capillaries or smaller veins, there are a great number of globules, No. 3" (lymph globules); "and it is quite extraordinary to observe the difference in movement between these round speckled globules and the oval ones; the blood-globules pass in a continued stream, while in the same fluid, in the same vessel, are a great multitude of other (lymph No. 3) globules, which do not move, or do so very sluggishly; every now and then they move slowly, apparently urged on by the repeated knocks they receive from the blood-globules. It would appear that, after the capillary vessels have been acted on by the salt, the round (lymph) globules accumulate in an unusual manner, and the blood-globules repeatedly slide over and knock against them. In some of the vessels there is a rapid stream of blood in the centre, whilst at the circumference there are many stationary, round, spotted globules, which do not obey the impulse which urges the stream of blood, but remain or move on slowly by little starts, at uncertain intervals, and with unequal pace." This account corresponds very exactly with what I have myself observed; but I should not consider the experiment so conclusive with regard to inflammation, inasmuch as the chemical action of the salt might have been concerned in the production of the lymph-globules, as salt seems to generate granules in the blood-liquor. In my observations, I was careful to use no irritant which has any known chemical action on the blood. The greater prevalence of lymph-globules in the motionless layer had been noticed by Wagner and others, and their more abundant production in an inflamed part has been mentioned by Mr. Gulliver. The presence of the pale corpuscles in inflamed vessels has been questioned by Dr. Hughes Bennett, who hints that Mr. Addison and myself may have mistaken for them epithelium cells lining the vessels; but the plain description above given, and which I have repeatedly verified, admits of no such interpretation. The granular corpuscles may be distinctly seen to roll sluggishly and with a *dragtail* before they stop; which they obviously do by adhesion to the interior of the vessel. I cannot understand why Dr. Bennett has failed to see so clear an appearance.

always found considerable or continued irritation of the vessels in the frog's web to be attended with the appearance and adhesion of the colorless globules; and that when the irritant is at all strong, or frequently applied, many vessels become totally obstructed, appear larger and redder in consequence of the accumulation of red particles in them (the blood-liquor having passed on), and exhibit to the naked eye all the appearance of inflammatory injection. The chief cause of obstruction seems to be comprised in the two circumstances: the *increased production of the white globules*, and *their remarkable disposition to adhere to the walls of the vessels and to one another*; each of these circumstances must now be noticed.

The origin of the white or lymph corpuscles (§ 195), seen in the blood, is involved in some doubt. They are distinctly spheroidal bodies, of a gelatinous consistence, and composed of granules, some of which have the appearance of nuclei. According to Mr. Addison,[1] they are invested by a delicate membrane, constituting a compound granular cell. which slowly by the action of water, more promptly by the operation of solution of potass, bursts and discharges granules and molecules. In this respect, they differ from the blood-disks, which are speedily burst, and are almost dissolved by either of these fluids. They appear to consist of fibrine, or rather deutoxide of proteine; and, as in the case of other granular bodies formed in an albuminous fluid, each granule probably has a central nucleus or molecule of fat, which makes their specific gravity lower than that of the red particles; hence their disposition to collect in the buffy coat of inflamed blood. The increased number of these bodies within the vessels of an inflamed part has been observed by Mr. Addison as well as by myself; and from careful comparison with those in uninflamed vessels, I infer that this increase is due not merely to their being *arrested* in their transit through the inflamed vessels, but to their being actually formed in greater numbers.[2] Nor is it difficult to explain their production, if we consider the combination of causes which are operating in inflamed vessels. The blood-liquid is highly charged with proteine, which needs only a farther process of oxidation to assume the solid form of the deutoxide; this process is supplied by the free current of arterial blood (determination) which rushes into the obstructed portions, and brings the red particles, the oxygen-carriers, in such forcible contact with blood-liquor as favors the transfer of oxygen to the proteine contained in it. As the proteine becomes oxidized, it consolidates in a granular form, and the more readily around the oily molecules always diffused through the blood-liquid; and these form the nucleoli visible in the larger granules. But the granules also cohere in clusters, and form the pale corpuscles of various sizes which appear adhering to

[1] Trans. of Provincial Med. and Surg. Assoc. 1843, p. 240.

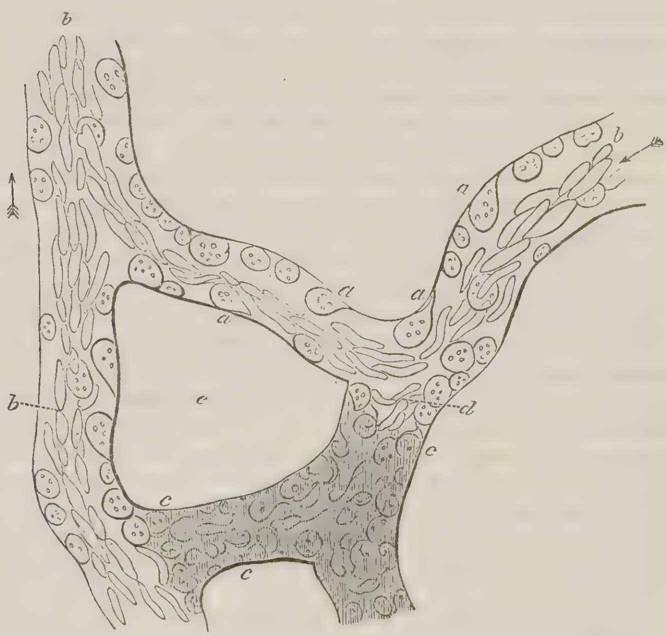
[2] This statement, which corresponds with that given previously (§ 415), has been made the subject of animadversion and inconsiderate ridicule by parties who find it easier to criticize observations which oppose their own notions, than to investigate the matter carefully themselves. It will be perceived that the pathology of the blood in inflammation indubitably proves that the pale corpuscles are increased not in a part only, but in the whole blood: whereas, if they were only accumulated in the inflamed part, there would be fewer than usual in the blood at large. In the former edition, I stated the fact; the advance of animal chemistry enables me now to offer its explanation.

and creeping along the sides of irritated vessels.[1] This explanation corresponds with the sudden manner in which they appear in such numbers in the vessels of the frog's web, not only after continued irritation, but after momentary rough handling or squeezing the web, which partially obstructs the vessels and directs the force of the arterial current on their contents; the walls then appear studded with adherent and creeping corpuscles; but as the impediment and the determination are not here permanent, these corpuscles are soon swept away and disappear. In inflamed vessels, on the other hand, they are a constant element, and, as we shall find, are chiefly instrumental in producing its phenomena and results. Their abundance in inflamed blood has been noticed by Gendrin, Gulliver, Addison, and others.

417. We have next to notice the peculiar disposition of the pale cor-

[1] The accompanying diagram exhibits the appearance of a small portion of the capillaries of a frog's web after the application of a grain of capsicum. The elliptical blood-disks (*b*) are running in the axis of the vessel, which is much narrowed by white globules adhering to the walls, or only slowly rolling along them. These globules are speckled with nuclei or granules, refract the light strongly, and when rolled on by the current, some of them become pear-shaped from their sticking to the vessel, thus forming a kind of dragging tail, seen very well in those marked (*a*); on altering the focus, similar globules may be seen ad-

Fig. 10.



hering to the other parts of the vessel. The shaded portion (*c*) is totally obstructed with white and red particles, so impacted together as to form a homogeneous red mass. In such a case I have often seen the particles at (*d*) exhibit a pulsating or oscillatory motion (corresponding with the action of the heart); and this, after a time, succeeds in breaking down the obstructing mass, which passes away in clots, leaving the vessel (*c*) studded with pale corpuscles like the other; and this result is observed whether the obstruction has taken place suddenly, or slowly, showing that in either case these corpuscles are present.

puscles to adhere to the walls of the vessels. This disposition has been ascribed to a vital attraction; but although it is made subservient to the purposes of life and organization, it appears to me to be the mere result of the physical property of adhesiveness common to soft solids of glutinous material. The same property is shown in the field of the microscope, in the manner in which the pale corpuscles stick to the glass, whilst the red particles float in the liquid. It has, however, been objected that in blood drawn, "the white corpuscles do not show any tendency to adhere to each other or to the red particles, which they naturally would do if their surfaces were adhesive enough to cause them to stick to the walls of the vessels."[1] But this objection has no force when it is considered that the white corpuscles do cohere most readily when brought into contact; and the reason why they appear separate in the field of the microscope, is because they at once stick to the glass, and are not free to move and congregate like the red particles. They do not usually adhere to the red particles because they are smooth loose sacs of fluid, the exosmotic properties of which are intended to keep them as loose and free as possible, so that they are carried with every motion of the current.[2] But there are circumstances in which the red and pale corpuscles do cohere together; and that is when their compression within the vessels prevents exosmosis; so also there is a condition of the walls of the bloodvessels in which the pale corpuscles adhere little or not at all to them; and that is when endosmosis through their walls is as free as exosmosis, in the absence of all distension of the vessel; and this explains why, in the instance before mentioned, the pale corpuscles which adhered, become detached as the circulation is restored to its natural state.

The ordinary pale corpuscles of the blood certainly have an investing cell-wall, as first shown by Mr. Addison; but those recently formed in inflamed vessels do not appear to me to be so invested, and hence their more adhesive property. But they soon acquire this covering, which seems to be nothing more than an outer coating of coagulated albumen or deutoxide of proteine more solid than the rest of the corpuscle. In like manner, globules of milk, oil, &c., acquire in serum an albuminous coating, as observed by Ascherson, Donné, and Gulliver. I am aware that the expression of this opinion will not be favorably received by those who uphold the doctrine of cell-life as fundamental to all processes of organization; but we have already noticed facts in regard to the organization of fibrine (§§ 211, 212) which show that this doctrine is by no means of universal application.

418. Except as the chief vehicles of oxygen, the red particles are less concerned than the white corpuscles, in the commencement of the obstruction of inflamed vessels; they are seen still free, although twisting and struggling between the accumulating white corpuscles; and so long as they so pass, *they show no disposition to cohere or form rouleaux;*

[1] British and Foreign Medical Review, July, 1844, p. 107.

[2] These physical differences may be rudely illustrated by a clot of adhesive jelly and a thin bladder containing water; the jelly adheres to any plain or concave surface, so that it may not be detached by inversion; the bladder rolls readily when the surface is inclined, and will not adhere even to the jelly.

but if the obstruction increase a little by another white corpuscle or two more, so narrowing the path that the red particles can no longer pass, then these also stick, and, forced by the current from behind, their flexible and elastic bodies become jammed in such numbers in the interstices of the white corpuscles, that the whole vessel speedily presents an almost homogeneous deep red color, and contains a great accumulation of red particles, the liquor sanguinis having filtered through. This is the period of total obstruction, the process of which may be watched when the irritation is extremely gentle; but in most instances it is produced so suddenly and extensively that the successive changes escape observation, and the contents of the vessels at once appear stagnant and uniformly red, as if the blood had suddenly coagulated with them. These appearances are illustrated in the diagram (p. 232), and serve to explain the vascular redness of an inflamed part, and, as we shall see, will aid us in understanding the farther results of the inflammatory process.

It seems, then, to be well established, that an essential part of inflammation is the production of numerous white globules in the inflamed vessels; and that the obstruction of these vessels is mainly due to the adhesive properties of these globules. The production of these globules must then be considered as a constant fact in the history of inflammation and nutrition; but it may be observed that sometimes it seems to be the direct effect of an irritant acting on the bloodvessels and their contents (§ 415); in other instances, rather to result from determination of blood into previously congested capillaries (§ 414). Any circumstances causing continued determination of blood, where congestion is already present, will occasion the production of the white globules, and, consequently, inflammatory obstruction may ensue. The complete obstruction of some capillaries by the confused conglomeration of the corpuscles takes place in all cases of severe inflammation of the frog's web; but there are slighter kinds of increased vascularity, in which there is no total obstruction, but a continued enlargement of the capillaries and veins, as well as of the arteries. This might be called simple determination of blood; but it differs from that of a transient character, in the motion in the capillaries and veins being slower, and in the vast number of white globules seen moving slowly in them (§ 294). Very probably this kind of process takes place in the lowest forms of inflammation. Something of the kind is generally seen in the capillary circulation of young frogs.

419. The foregoing experiments and considerations lead to the conclusion, that the most essential character of inflammation consists in an increased motion or determination of blood to the affected part, with a more or less obstructed flow through the part; the force of the increased motion being partly expended in the arterial portion of the dilated capillaries (§ 414), and partly diverted into the collateral channels so abundantly supplied by the anastomosis of vessels (§ 410). The obstruction in the vessels of an inflamed part we have found reason to ascribe in part to the increased mass in the smaller vessels, and to the diminished elasticity of their coats; and in part, to the unusual formation of white corpuscles, which adhere to the walls of the tubes, and to each

other. Of the exciting causes of inflammation, the direct irritants (§ 402) seem to produce obstructions in both these modes; those which act indirectly (§ 403), on the other hand, in the first instance produce congestion—to which determintion of blood being subsequently added, the inflammatory process begins; hence the latter causes, although very common, are not so sure of exciting inflammation as direct irritants are.

420. The effect of these changes, essential to inflammation, is to expend much of the circulating force conveyed by the arteries on their capillary terminations; and the enlargement and tortuosity of these capillaries, the production of globules which adhere to their sides, and their total obstruction by the same means, seem to be so many progressive expedients used by nature to direct the force of the circulation to that part of the vessels by which the process of reparation and nutrition is chiefly carried on. We have farther suggested, that an obvious effect of this local direction or determination of force, is to supply oxygen more freely to the plasma, and the resulting formation of a solid deutoxide of proteine is the obvious explanation of the formation and increase of those white corpuscles which augment and complete the obstruction. This leads us to consider the farther changes effected by inflammation.

421. We have already found that an inflamed part is the seat of determination and of congestion or obstruction. It is this combination which leads to the changes which characterize inflammation, and which, in extent and variety, exceed the changes from any other kind of hyperæmia. The determination of blood to and near the obstructed vessels is attended with the usual results of determination (§ 333, &c.); but to a greater extent than usual, because the cause of determination is more permanent. The congestion or stagnation has also its effects (§ 303, &c.); but more marked and peculiar than usual, because the obstruction is more complete than in congestion in general, and because it is modified by the influence of a continued force of blood acting physically and chemically against it. All these circumstances point out that the natural functions of the vessels must be much modified by inflammation, and this in different modes in different parts of the inflamed site. Thus, in the vessels which are the channels of an increased flow, the functions will be more or less exalted or excited; whilst in those that are obstructed, vital properties will be more or less impaired. It is the approximation of such opposite conditions, excitement and interruption of living actions almost in the same spot, that renders continued inflammation so seriously destructive to structure as well as to function.

422. Inflammation at first much exalts sensibility (§ 133) and contractility (§ 111); causing tenderness, pain, and spasm. But the obstructed circulation may cause a suspension of these properties (§ 273) in the centre of the mischief, whilst in surrounding parts, the seat of determination, they are exalted. The sympathetic relations (§§ 152, 156) of the inflamed part are also commonly increased. Natural secretions are either suspended by inflammation, or modified by the addition of various modifications of the serous and albuminous parts of the blood. This involves the change of nutritive secretion, which is so important and early a part of inflammation that it must be noticed more fully. We

shall recur to the other effects of inflammation under the head of symptoms.

423. The effusions from inflamed vessels at an early period are much the same as those from tense congestion (§§ 305–8) and determination of blood (§§ 340, 1); but they commonly occur in greater abundance, contain more animal matter, and, as the inflammation advances, they sometimes present appearances not found in the products of mere congestion or determination. Thus the effusion at first is a thin serum, causing swelling in complete textures, accumulating in the dependent parts of serous cavities, or diluting the secretion of the more simple mucous membranes. But soon fibrine is also effused, part of which may concrete into coagulable lymph, or still remain dissolved, as in the liquor sanguinis. Thus an inflamed pleura becomes coated with a film of lymph; and the clear fluid effused into the sac, when removed from the body, sometimes spontaneously separates into a fibrinous clot and serum. This occurring in complex textures gives a hardness to their swelling, as in phlegmon of cellular membrane, hepatization of the lung, &c. In mucous membranes, there may be thickening of the submucous texture, and the mucous secretion becomes unusually viscid.

424. The microscope has supplied much detailed and precise information on the nature of inflammatory effusions, although there is yet room for farther research on their varieties and relations to each other. In the frog's web, after inflammation has continued some hours, there appear outside of the vessels (especially of those in which the strongest current encounters the most complete obstruction) white globules or corpuscles with specks in them, exactly like the pale granular globules within the vessels (§ 415). These are also found in various inflammatory effusions, and are called *exudation corpuscles*, *granule cells*, or *fibrinous globules*. Mandl supposes them to be merely consolidated globules of fibrine, and states that the liquor sanguinis may be seen to coagulate in similar globules on the glass of the microscope. But these latter have been shown by Gerber to be mere albuminous granules, without regularity of form, and quite unlike the true exudation corpuscle, which also consists of granules, but has a defined outline, and in many instances an investing cell, whence the term *granule cell* (Vogel). In addition to these bodies, the fibrine effused by an inflamed membrane also contains a mesh of extremely fine fibres, first noticed by Messrs. Gulliver[1] and Addison.[2] Both these observers describe the nucleated or granulated corpuscles as occurring among these fibres, together with more minute granules and molecules, which appear to be similar to those which compose the corpuscles. Lastly, some portions of solid effusion present no distinct structure, but are either irregularly granular like coagulated albumen, or completely amorphous and homogeneous (Vogel), *hyaline* (Gerber). Now, some or all of these solids appear in inflammatory effusions, although they occur in very various proportions, and present different modifications, to be noticed hereafter. The following is a summary of these elementary solids of inflammatory effusions:—

[1] Note to Gerber's General Anatomy, p. 31. [2] Med. Gaz. April 15, 1841.

1. *Molecules*, immeasurable from minuteness, each appearing as merely a dark speck. Probably composed of a fatty matter (Davy, Gulliver). (*Smaller primitive molecules;* Gruby.)

2. *Granules* (Gerber, Addison), measuring from $\frac{1}{12000}$ to $\frac{1}{8000}$ of an inch, appearing as a light spot, surrounded by a dark circle. Probably consisting of deutoxide of proteine, with a central molecule of fat. (*Larger primitive molecules*, Gruby.)

3. *Fibrils*, extremely fine, interlaced and decussating, the same with those seen in the buffy coat of the blood (§ 194).

4. *Lymph or exudation corpuscles, compound granules, granular cells*, measuring from $\frac{1}{6000}$ to $\frac{1}{700}$ of an inch (Gulliver), composed of granules and molecules, and sometimes enveloped in a cell.

5. *Pus-globules* appear to be enlarged modifications of the last; but more distinctly cells, containing liquid with more or fewer granules, some of which are of larger size than the rest, and forming nuclei. Besides the solid deutoxide of proteine, which constitutes these solid parts, they contain a dissolved form of proteine, the tritoxide.

6. Irregular granular and hyaline matter; the former of albuminous composition, with more or less fat; the latter also albuminous, with more or less gelatine. These constitute the materials of tuberculous and other aplastic or cacoplastic deposits (§ 212). They often exhibit traces of cells and fibres, but appear degenerated or imperfectly formed.

In addition to the above, inflammatory effusions usually contain the usual solids generated by the part, such as mucous globules, epithelium scales, epidermis, and also blood-corpuscles.

425. Of these elementary solids, the fibrils certainly may form from the effused liquor sanguinis out of the vessels, and even removed from the body (Addison); but it is a question whether the others concrete spontaneously from the liquid fibrine, or grow from germs (molecules or granules) disseminated from the vessels or adjoining textures. The close resemblance of the exudation corpuscles and their contents, to the white globules and granules, so abundantly produced in the blood of the inflamed vessels, would seem to indicate their identity; but it is not easy to understand how they pass through the walls of the vessels, in which no pores are visible under the highest magnifying powers. Mr. Addison has, indeed, represented the white globules as first passing into the substance of the wall of the bloodvessel, and then beyond it; but this would seem too slow a process. It would appear more probable either that nuclei or molecules, too small to be discernible, do pass out in this way, and then grow and propagate compound granules (granular and pus corpuscles); or, that these corpuscles are formed by coagulation in the effused liquor sanguinis as the fibres of fibrine certainly are.

426. These solid products of inflammation are the materials of which new membranes, textures, and deposits are formed; and present every variety of plasticity, or capacity of organization, from that of perfect cicatrices and false membranes, down to that of yellow tuberculous matter.[1] As we shall have to notice these farther, under the head of results

[1] This statement, which is founded on the recent microscopic observations of Gerber, Gulliver, Addison, Watt, and others, is a remarkable confirmation of views on the nature of pus and tubercle, which I have entertained for the last twenty years, and to which I adverted in the following sentence, published nineteen years since: "I am myself disposed

of inflammation, we shall now review inflammation in relation to its farther consequences and symptoms.

427. Inflammation is always attended with more or less effusion. Where the inflammation is slight, this effusion may remove it by unloading the engorged bloodvessels; but where the inflammation is more intense, that is, where the obstruction is considerable, and the determination of blood strong, the effusion may go on to a great extent without resolving the inflammation. It is then that the more serious effects of inflammation result. The effused matters press on, and pervade the adjoining textures, derange their nutrition, and impair their cohesion; and thus takes place the *softening* of textures, which occurs chiefly in those of a complex kind, which retain the effused matter. The continued obstruction in the inflamed part, leaves the veins and lymphatics free to absorb, and the high pressure and determination of blood tend rather to promote this process of absorption. Hence, as new matters are effused, the old texture is compressed, disintegrated, and absorbed; the finer exudation corpuscles and fibres themselves are removed or altered, and the large pus-globules alone remain; this is *suppuration.* Or, if the original obstruction of the inflamed vessels be extensive, or have been rendered so by the subsequent effusion, the supply of blood may be so stopped in a part that it dies, and the dead part may then either be only dissolved and absorbed at its circumference, and separated from the living textures in form of a *slough;* or, if more extensive, the dead part may pass into decomposition before it can be separated; thus occur *gangrene* and *sphacelus.* If the inflammation be of a lower kind, the obstruction less complete, and the effusion more gradual, the nutrition of the natural texture is only impaired, not arrested, and from the increased deposition of solid matter, *induration* or *consolidation* takes place.

SYMPTOMS AND EFFECTS OF INFLAMMATION.

428. We have described the process of inflammation in its intimate nature and phenomena; we have now to notice its more obvious effects on function and structure, which become *symptoms* of its existence. These symptoms may be divided into *local* and *general;* the local occurring chiefly in the part which is the seat of inflammation, the general affecting the system at large.

LOCAL SYMPTOMS.

429. We have before stated that the local symptoms are commonly more marked, and earlier in order of occurrence when inflammation is excited by local irritation (§ 402); the fever which afterwards supervenes may even disguise the local symptoms. The chief local symp-

to consider tubercular matter, pus, and coagulable lymph, only as varieties of the same albuminous matter that exists in the blood, and differing from each other rather in mechanical condition, and consequent capability of organization, than in chemical composition."—*Rational Expos. of Physical Signs of the Diseases of the Lungs and Pleura,* 1828, p. 159.

toms have been already mentioned in the definition—*redness, heat, pain, and swelling*, to which may be added various disturbances of the function of the part affected. We shall explain and illustrate these symptoms.

430. The *redness* of an inflamed part is obviously due to the increased quantity of blood in the vessels. All these vessels are much enlarged, so that they receive many more red particles than usual; and the finest capillaries, which commonly are invisible from their admitting only the liquor sanguinis with now and then a red particle, are now distinctly colored from the number that pass into them. Some observers have thought that new vessels are formed by the blood forcing its way through the textures. I have never seen this in the frog's web; but it appears to take place in some textures which are not naturally vascular, such as the anterior part of the cornea, and cellular cartilage (Toynbee). But the microscope shows that, besides the augmented size of the bloodvessels which convey blood, much of the redness of inflammation arises from the vessels in which the blood is stagnant. The color of these is much more red than that of the vessels simply congested, or through which a current still passes; and this has before been referred to an accumulation of the red particles which takes place in them (§§ 415, 417, *note*). These vessels appear so impacted to their outmost limits with coloring matter, that the shape of the blood-disks and of the white corpuscles is no longer discernible; yet these are still present; for when an obstructed vessel reopens, the red mass breaks up into clots and particles, and many white corpuscles are left sticking to its walls. (See *note*, p. 237.) It is obvious, therefore, that the obstructed vessels become stuffed, as it were, with red as well as white corpuscles, which cause a brighter and stronger red than that of congestion. In many instances, too, it may be seen that the redness of an inflamed part is augmented by spots and patches of extravasated blood, which prevail especially in some varieties of inflammation.

The redness of inflammation presents great varieties, according to the number and distribution of the capillary vessels of the part; but its most essential seat being in the capillaries, its most constant character is a diffused or capilliform redness. This is commonly far more vivid and general in the living than in the dead body. In the skin and mucous membranes, during life, it is often seen as a uniform blush of color, varying from a delicate pink to a bright crimson. After death, this blush has sometimes entirely disappeared; but commonly more or less of it remains; and, on examination with a lens, it is found to consist chiefly of numerous vesicular striæ, network, or points, with here and there larger vessels and ramifications also injected. But the large vessels (veins) are distended much less generally than in congestion (§ 280), and the redness is therefore less arborescent and ramiform. To explain the reason of the disappearance of inflammatory redness after death, we must bear in mind that much of it depends on determination of blood (§ 326) which is maintained by the action of the heart, distributed by the arteries; and that when this ceases in death, the tonic contraction of the arteries, which survives for a few hours, expels the blood from the vessels (§ 120). A similar effect is sometimes produced during

life, by cardiac syncope. The redness that remains after death seems chiefly to consist of the vessels which have become totally obstructed and impacted with blood, or have been long congested and have lost their tone (§ 295). This furnishes us with a useful means of distinguishing in different cases the comparative prevalence of the elements of inflammation. Thus, in cases in which the redness disappears after death, we may know that the predominant element was local determination of blood (§ 409), without much obstruction or permanent congestion. This is observed in erythematic and diffused membranous inflammations, the cutaneous inflammations of eruptive fevers, and the early stages of all inflammations excited by moderate local irritation (§§ 402, 415). On the other hand, if much redness remains after death, we may infer that obstruction or congestion of the vessels has existed to a great extent. This happens especially in phlegmonous inflammations, those of parenchymata, and others which have advanced to a certain intensity, and those which have originated in congestion (§ 403).

The florid hue of the redness is also, during life, a sign of the predominance of determination, for it shows that the blood is chiefly arterial and not stagnant. Where congestion prevails, or where the blood has been long stagnant in many vessels, the color is deeper; but it is rarely so deep as in pure congestion, for the presence of white globules tends to lighten it or give it a florid tinge, and it is probable that the red particles stagnant in the vessels retain their power of receiving oxygen from the communicating arteries, which are the channels of determination of blood. In the dead body, these distinctions are not equally available, for the arterial part of the blood may have been removed by the contraction of the vessels, or darkened by stagnation; and the livid portions speedily become florid on exposure to the air.[1]

The progress of inflammation modifies the redness. The color becomes more florid and deeper as the inflammation advances to its acme; it then becomes either livid before it subsides, or paler from the color of the effusion. In complex textures, the effused lymph or pus changes the redness to pink, flesh color, drab, or yellow.

431. The *heat* of inflammation is obviously dependent on the increased flow of blood to and through the part; and it may be considered the representative of the amount of determination of blood concerned in the inflammation. Hence it is high in extensive and active inflammation, and is generally proportioned to the florid redness or arterial vascularity. It is not certain whether the high temperature of an inflamed part is caused by the augmented changes going on in that part, or whether it arises merely from the greater quantity of warm blood which passes through it. John Hunter made some observations to determine this point, and never found that the temperature of an inflamed part was raised above that of the interior of the body, which it might be expected

[1] I have often, in the dead-house, seen mere congestive redness mistaken for inflammatory, because it was florid from the action of the air, or from the translucence of a subjacent white structure. Frequently, too, the claret stain of arteries and intestines is mistaken for inflammatory redness; a common lens will prove it to be not so, by showing that it is not vascular.

to be, if inflammation was in itself a calorific process. That extensive inflammation raises the heat of the whole body, as well as of its own site, is quite certain; but this may be simply by causing general excitement, especially of the circulation and respiration, and by repressing the perspiration and other exhalations, by which the body is naturally cooled. It seems, however, quite consistent with analogy to admit that inflammation, as a process of increased vascular action, may generate heat; and inasmuch as there is an augmentation of the red particles in the part, which are supposed to be chief agents in the generation of heat (through the oxygen which they supply), we see a reason why the calorific process may be exalted in the inflamed part. Increased heat is a very important and valuable symptom of inflammation, since it is more constantly discernible than any other, and serves to distinguish inflammation from congestion and nervous irritation, which may resemble it in other symptoms. But to indicate inflammation the heat must be continued, and not merely coming in flushes of simple determination of blood. Generally, the skin is dry as well as hot; but it may be perspiring, and yet a temperature, higher than natural, may be sustained.

432. The *swelling* of an inflamed part is caused, in some degree, by the enlargement of the vessels, but chiefly by the effusions from them, and will be, therefore, proportioned to the amount of these; but the situation, form, and degree of the swelling, will also greatly depend on the natural structure of the part inflamed. In serous membranes, the vessels being comparatively few, admit of but little enlargement; and the effusions, not being retained by complexity of structure, soon overflow externally, and chiefly accumulate in the most dependent parts of the serous sac, causing dulness on percussion, and sometimes fluctuation in the chest and abdomen, and, when in large quantity, distending these cavities. Mucous membranes are more vascular and complex in structure; hence the enlargement of vessels early causes some thickening; but the swelling is chiefly due to interstitial effusion in the submucous tissue (so manifest in coryza and cynanche); this effusion, when merely serous, soon passes off in the thin flux which attends catarrhal inflammations, and the swelling may subside with it; when the effusion is more solid, the swelling remains longer, is attended with a more viscid secretion, and subsides only when this secretion becomes opaque, and somewhat fat in its composition. The skin presents great variety in the swelling, as well as in the redness caused by inflammation. Sometimes the swelling is diffused and hard, as in cutaneous erysipelas. In urticaria, the same hard swelling occurs in spots or patches, and the effusion in parts supersedes the vascular redness, causing white centres, or wheals. In tubercular inflammations of the skin, the redness and swelling are still more circumscribed, and the effusion seems to be chiefly solid. In papulæ, the swelling is even more minute, and confined to a point. In blebs and vesicles, the effusion is between the cuticle and the true skin, and the swelling is confined to corresponding patches or small spots. Inflammation of cellular texture is attended with considerable swelling; this being diffused, œdematous, and pitting on pressure when the effusion is serous; being more tense when there is fibrine with the serum; and being hard and subscribed (as in phlegmon) when the mat-

ter effused is chiefly fibrine. Parenchymatous organs, in like manner, are remarkably swelled by inflammation. The liver, kidneys, testicles, lymphatic and other glands, attain a large size from the mere distension of their bloodvessels; and we have noticed a similar result from mere congestion (§ 293); but inflammation does not last long in these structures without causing effusion, which, by various proportions of serum and lymph, may cause swelling, varying in its firmness. The lungs, from their porous structure, do not swell materially in bulk; but the effusion displaces the air in their cells, thus increasing their weight, and if the effusion abound in lymph, converting them into a more or less solid mass, like liver (hepatization).

433. The *pain* of inflammation is caused by that exaltation of sensibility (§ 135) which determination of blood produces (§ 333), often increased by the tension or pressure arising from the swelling. The amount of pain will, therefore, depend much on the natural sensibility of the part, the degree in which determination of blood predominates, and the tension or pressure induced. The severest pain arises where these circumstances co-operate, as in inflammation of the pulp of a tooth, the sheath of a nerve, the lining of a bony canal, as the auditory meatus, &c. In other cases, pain chiefly felt when the inflamed part is pressed or stretched, constituting excessive tenderness. Thus the pain of peritonitis is felt on pressing the abdomen, or on straining the walls by coughing or vomiting; the stitch of pleurisy is felt on taking a full breath; the pain of external inflammation and rheumatism, on motion, or pressure on the limbs. In enteritis, there may be little pain until the intestines become spasmodically contracted in some parts, and distended in others, by flatus and other contents; hence the pain may vary, whilst the inflammation remains the same. Parenchymatous organs and mucous membranes being comparatively soft and yielding in texture, are not the seat of much pain when inflamed. In the early stage, pain, with heat, may indicate the activity of inflammation, that is, the prevalence of determination of blood. In the more advanced stages, the pain rather bears relation to the amount of tension from swelling or effusion, and is commonly relieved when this becomes more diffused, or ends in suppuration.

434. Besides pain and tenderness, sensibility increased by inflammation sometimes exhibits other modifications, such as feelings of soreness, tingling, heat, itching, &c. Peculiar sensations are also excited in the organs of special sense when they are inflamed, such as noises in the ears, painful and disturbed vision, &c. The peculiar sensibility which excites the motions of sneezing, coughing, vomiting, micturition, and defecation, is exalted, when respectively the Schneiderian membrane, the lining of the upper part of the air-tube, the cardiac end of the stomach, the bladder, and the rectum are inflamed. Other sympathetic sensations (§ 156) excited by inflammation are peculiar to disease, as the pain in the shoulder-blade, with inflammation of the liver; pain in the testicle, with inflammation of the kidney; pain of the glans penis, in inflammation of the bladder; pain of the knee, with inflammation of the hip.

435. Contractile fibre is not itself prone to inflammation; when the

parts contiguous to it are inflamed, the effect is commonly first to increase its irritability (§ 113), and subsequently to impair it, probably by exhaustion. Thus the heart, when its membranes are inflamed, acts first with great force and frequency, but subsequently with feebleness and irregularity. When the intestines, bladder, or air-tubes are inflamed, there is contraction followed afterwards by more or less weakness of the muscular fibres of these parts.

436. Other functions are somewhat similarly affected under the influence of inflammation. In inflammation of the brain and its membranes there is commonly at first more or less excitement of the sensorial functions, causing delirium, hallucinations, and convulsions; afterwards ensue stupor and coma, and paralysis. In the early stage of inflammation of the spinal cord, there may be tetanic convulsions; afterwards follows paralysis. Often symptoms of partial excitement are conjoined with others of interruption of function; and this is not extraordinary, seeing that inflammation comprises diminished as well as increased flow of blood, and the former generally predominates as the inflammation advances and effusion proceeds. Inflammation of the lungs causes dyspnœa; that of the stomach interferes with digestion; inflammation of the kidneys suspends or impairs their secreting power, &c. Farther details belong to special pathology.

CONSTITUTIONAL SYMPTOMS OF INFLAMMATION.

437. The irritation of inflammation frequently extends itself to the symptom at large. The functions of the whole body are more or less disordered. The contractions of the heart are more frequent and forcible than usual; the arterial tonicity is increased (§ 121); hence the pulse is quick and hard; the skin is dry and hot; the appetite and strength are impaired; and the natural secretions are diminished and otherwise disordered. This is *inflammatory fever*.

438. Among the most important general effects of inflammation must be noticed the change in the condition of the whole blood. We have before noticed, that there is an excess of fibrine and of the colorless globules in the blood in inflammatory diseases (§ 195); and that the separation and contraction of this fibrine (§§ 203, 4) take place in an unusual degree, and produce the peculiar buffed and cupped appearance of the clot so remarkable in inflamed blood (§ 208). This excess and separation of fibrine displayed in the buffy coat is commonly proportioned to the extent of the inflammation and its duration in an active state. This would suggest that the change in the blood is altogether produced in the bloodvessels in and near the inflamed part; and the increased development of white globules, seen by aid of the microscope (§ 415) (which, chemically speaking, is an oxidation of some of the proteine), is a kind of demonstration of this production. This supposition derives support from the fact that blood drawn directly from an inflamed part is more buffed than that drawn from a distant part.[1] This excess and separation

[1] I have observed this even in blood drawn by cupping, on a part inflamed by the previous application of a blister.

of fibrine is more remarkable in inflammations of serous membranes than in those of mucous membranes, or parenchymata, which may perhaps be ascribed to the former inflammations being attended with less local vascular distension and overflow of the exudation corpuscles and fibrine. Acute rheumatism presents the highest degree of the buff and cupping of the blood; perhaps because the inflammatory irritation arising from matter in the blood itself[1] (§ 251) affects a great many vessels, yet without completely obstructing them, so that determination of blood predominates over congestion; and although there may be much inflammation and effusion of the early kind (§ 423), this does not lead to suppuration or other of the more destructive changes which follow inflammation. It has been before mentioned (§ 245), that an increased activity of circulation and respiration might contribute to augment the fibrine of the blood in acute rheumatism and other inflammations not impairing the respiratory function; but it was then objected that the increase of the fibrine is sometimes observed in rheumatism without much acceleration of the pulse and breath; and, on the other hand, in fevers in which the pulse and breath are much hurried, the fibrine of the blood is even diminished (§ 196). And it was found by Andral and Gavarret, that, in fevers, the occurrence of local inflammation always caused an increase of the fibrine in the blood.

It seems pretty clear, then, that the increase of fibrine, and its more contractile and separating quality, originate in the vessels of the inflamed part, and must be regarded as an augmentation of the process of nutrition developed by inflammation. A similar augmentation takes place in the vessels of the uterus during pregnancy, when the blood drawn generally exhibits a buffed appearance; and, although such an appearance is not commonly presented by blood drawn from fast-growing children during health, yet in them it is very readily induced by inflammation, and the plastic products are unusually copious. It has been mentioned (§ 415), that in young frogs, even in health, many white globules are seen in the bloodvessels adhering to or moving slowly along their sides; and this appears to be a proof of the activity of the same nutrition or plastic process, which is exalted to its highest degree in acute inflammation.

439. It has been supposed that the inflammatory or fibrinous state of the blood is the cause of the general excitement constituting the symptomatic fever accompanying inflammation; but it may be objected that this fever frequently rises high before the blood has begun to exhibit the buffy coat, often subsides when the buffy coat is most abundant, and is sometimes wholly absent when the blood is both buffed and cupped, as in subacute rheumatism. It is very probable, however, that the excess of fibrine may contribute to the excitement; and it certainly materially affects the duration and products of the inflammation.

440. In inquiring into the pathology of inflammatory fever, we must bear in mind that it sometimes precedes the distinct development of the local inflammation, being, in fact, a general excitement or reaction after the disturbing influence of the exciting cause. This is especially the

[1] The buffed appearance of the blood in inflammatory dropsy admits of a similar interpretation (§ 385).

case where inflammations are produced by cold, fatigue, and other causes which first induce congestion (§ 403). The operation of these causes is at first depressing to the whole system; and the continuance of this marks the cold stage of the fever, with weak pulse, coldness of the extremities and surface, general pallor, various uneasy feelings, dejection of spirits, and depression of strength. Afterwards ensues the reaction, beginning with rigors, accelerated pulse and breathing, sometimes vomiting, and other functional disturbances; soon the skin becomes hot, the pulse hard, as well as frequent; uneasy feelings in the head, back, and limbs are experienced, with thirst, loss of appetite, restlessness, and much weakness. It is during or after the establishment of this reaction that the local symptoms of inflammation may become prominent. During the cold stage, they may have been chiefly those of congestion of the affected organ (§ 303), impaired function, with more or less uneasiness; but now pain (§ 433), heat (§ 431), and various symptoms of local irritation (§ 434) ensue; and frequently, as these become developed, the general disturbance is somewhat reduced or modified. In eruptive fevers, the general disturbance and functional disorder are greatest before the eruption (or local inflammation) appears. In inflammation from cold or fatigue, the first disorder sometimes resembles that of continued fever, which is changed for simple inflammatory fever as soon as the inflammation is pronounced. In other cases, again, chiefly those which originate from local irritation (§ 402), the inflammation is developed, and its symptoms are prominent, before the symptomatic fever is excited. Generally, the fever is in proportion to the severity or active character of the inflammation; and if it were always so, we might conclude that the fever is the result of a reaction from the disturbance of the circulation produced by the inflammation; but we sometimes find inflammation of trifling organs, such as the tonsils, attended with a very smart fever; and much greater disturbances of the circulation, such as congestions of the lungs and liver, take place without causing any fever. It seems more probable, then, that the fever accompanying inflammation arising from local irritation, is caused by an exciting influence propagated from the inflamed part to the heart and arteries through the medium of the nerves. The same influence also sustains the inflammatory fever in the cases before noticed in this paragraph, in which the first febrile movement seems to be the result of reaction.

441. It still remains unexplained why, in fever, the circulation and some functions are excited, whilst others, as secretion, muscular strength, and the appetites, are much impaired. We may partly solve this difficulty, if we may point out that the excitement is not one of a healthy kind, being attended with an excessive tonicity of the arteries (§ 121), which is the cause of hardness of the pulse, and which may transmit the blood through the capillaries too rapidly to permit of its proper changes by excretion. It is also possible that the vital powers of secretion (§ 158) may be more directly impaired by the inflammation or its cause; for it is certain that, either as cause or effect, imperfect secretion is one of the most prominent elements of fever in general. Thus the bowels are generally costive; the urine scanty and high colored; the skin dry; the tongue clammy, with thirst; and ulcers or sores, that may have been

discharging before, now become dried up. So, too, on the subsidence of the fever, all these secretions are restored.

Finally, we may sum up the causes of the symptomatic fever of inflammation under three heads: 1. Reaction after the depression, induced by some exciting causes, such as cold, fatigue, &c. 2. Irritation communicated from the seat of inflammation, probably through the nerves; most prominent in irritable constitutions. 3. The altered condition of the blood, comprising an excess of fibrine, and retention of excrementitious matter; these especially sustain the fever.

442. The fever accompanying inflammation is generally *high*—that is, attended with hard pulse, hot skin, and general excitement—in the young, the sanguine (§ 38), and plethoric (§ 279); those, in short, in whom the vascular system is naturally active (§ 401). On the other hand, it is commonly *low*—that is, with weaker, though sharp and quick pulse, less general heat of skin, and with tongue more foul, and functions often rather oppressed or disordered than excited—in persons of phlegmatic temperament (§ 40), and in those weak from age, disease, malnutrition, intemperance, or confinement. The type or character of the fever also varies with the seat of the inflammation, and the particular textures affected, although the variation is less constant than it is generally represented to be. It is commonly stated, that the fever is high in inflammations of most serous and fibrous textures, and in phlegmonous inflammation of cellular texture; that it is low in inflammation of the stomach and intestines, kidneys, large joints, and in diffuse inflammation of cellular texture; and that the fever is of an intermediate character in inflammation of mucous membranes and parenchymata. Clinical experience, however, shows that there are many exceptions to these statements; and where the type of the fever is affected by the texture, it is chiefly by the intensity of the inflammation and the nature of its product. Diffused inflammations, of little intensity, often excite very little fever, and few local symptoms. The reverse is the cause of very acute inflammations, even of moderate extent.

443. The exciting cause, or some co-operating influence, often materially affects the type of the fever. The inflammation occurring after serious accidents or burns is often attended with a low fever, the reaction being imperfect from the continued depressing influence of the cause. The same remark is applicable to the case of inflammation from poisons, which are locally irritant, but sedative to the system. Even the long operation of cold may so depress the vital powers—especially that of the heart (§ 75)—that the reaction is imperfect, and the fever is low; in all these cases the symptomatic fever is typhoid or adynamic (§ 25), with weak and unequal as well as frequent pulse, varying heat of skin, sometimes with partial sweats; a much furred, and often dry and brown tongue; extreme depression of strength; low delirium, and other nervous symptoms. These are indications of disordered state of the blood like that induced by morbid poisons (§§ 186, 191); and it receives an adequate explanation in the want of purification and elimination from which the blood suffers in its congested and imperfectly circulated state; and the evidence of this change is afforded by the altered state of the blood-particles, the presence of urea, and signs of

incipient decomposition which have been observed in the blood in such cases, especially those of typhoid pneumonia (§ 25).

444. In the lower forms of inflammation (§ 442), the fever may be remittent or even intermittent; a state of depression alternating with a state of excitement, ending with perspiration; and when inflammations become chronic, or are of slight character, they may excite no fever at all. They generally, however, induce some constitutional disorder, in which defective excretion (§ 171) is commonly a predominant element. When it is borne in mind that inflammation includes determination of blood, it will be obvious that, besides the irritation connected with it, there may be more or less exhaustion of other parts of the body (§ 331); the part inflamed being over-supplied with blood, other parts are in want. This effect is most obvious in anæmic and debilitated subjects; and to it must be ascribed the weak circulation, coldness, disordered functions, and gradual emaciation of the body in general, when a part long suffers from low inflammation. The blood itself also soon becomes impoverished in continued inflammation, losing progressively its proper amount of red particles, and the fibrine in protracted cases loses its organizable character and degenerates into cacoplastic or aplastic matter.

NATURE AND SYMPTOMS OF THE TERMINATIONS OR RESULTS OF INFLAMMATION.

445. The results or events of inflammation may be comprehended under four heads: *Resolution*, *Effusion* (including adhesion), *Suppuration* (including ulceration), and *Gangrene.* It must not be supposed that these often occur quite singly, or that they are so separated from each other by a very marked line; but these terms are conveniently attached to those results in which each respectively predominates.

Resolution consists in the cessation of the inflammation, and the speedy removal of any slight effusion. As the essential parts of inflammation appear to be determination of blood, with obstruction to its flow through some vessels; so the resolution of inflammation consists in the yielding of the obstruction and the subsidence of the determination, the vessels contracting to their normal dimensions. This may be well seen under the microscope. Sometimes nothing remains of the inflammation, but more or fewer of the white globules adhering to the sides of the vessels; but more commonly some vessels are still obstructed, and others congested, with the motion in them slower than usual, the determination of blood (enlargement of the arteries) having ceased. So, commonly, we find congestion remain in a part that has been inflamed; and not unfrequently a flux or watery effusion may result from that congestion (§ 375).

446. Resolution of inflammation may occur spontaneously in slight cases; or in consequence of treatment; or from the inflammation being transferred to another part. Some inflammations creep to adjoining parts, as in the case of erysipelas and some serpiginous cutaneous eruptions. Others affect similar textures in different parts of the body; and, being resolved in one part, appear in another; this happens in rheumatism,

which affects fibrous textures, and is transferred from limb to limb, or joint to joint, by what is called metastasis, or translation. This may be fairly traced to the mobility of the peculiar *materies morbi* (§ 402), the cause of the inflammation. A remarkable metastasis of resolving inflammation is sometimes seen in parotitis, the breast or the testicle becoming the seat of the new attack.

447. The occurrence of resolution is marked by a subsidence of the chief symptoms of inflammation; first, of the heat and pain, and, more gradually, of the redness and swelling. The heat usually yields to perspiration. The pain becomes gradually easier; and in some parts, as the skin, may pass into itching before it subsides. The redness sometimes simply fades; more commonly it becomes less florid, and may pass through shades of a livid or dusky hue before it vanishes. The swelling soon subsides; the effused fluids being so speedily removed by absorption, that effusion can scarcely be said to have been a result. Still, in some instances, congestion, or some of its results (§§ 274, 350), or nervous irritation (§§ 126, 152), remains behind after the inflammation has ceased.

448. The resolution of any considerable inflammation is marked by a reduction of the fever; the pulse becoming softer and less frequent; the skin moist with perspiration, sometimes profuse; the urine, becoming more copious, abounding in urea, and depositing, as it cools, a plentiful lateritious or branny sediment, consisting of lithate of ammonia. The constancy of this last change on the decline of inflammatory fever has led to the supposition that it is critical, and determines the removal of the disease. The lateritious sediment in the urine is a pretty certain symptom of the subsidence of fever, and of the amelioration at least of the inflammation which excited it; but it is uncertain how far it is the cause or the effect of the improvement. It indicates an increased excretion of the solid constituents of the urine; for there is often an excess of urea as well as of the lithates; and comparing this with the scanty secretion of urine during the febrile excitement and the decay of tissues and blood which is always taking place (§ 254), we can scarcely avoid the conclusion that these excrementitious matters had been accumulating in the blood from the impaired function of the kidneys during the fever; and that now, as the fever subsides, and their function is restored, the accumulated matter is thrown off. Now, although the function of the kidney must be first impaired to cause the accumulation of the excrementitious matter in the blood, yet this matter so retained tends to keep up the disorder (§§ 68, 171); and it is by means which promote the elimination of this matter that we succeed best in reducing febrile excitement. So, likewise, in cases where the function of the kidneys is permanently impaired by Bright's disease (congestive degeneration, § 309), inflammatory and other fevers are not readily brought to a termination; persons so affected are said to be "bad subjects," with "broken down constitutions;" and they often sink because their excreting organs are unequal to the increased task thrown on them. In cases in which the resolution of the inflammation is only partial or imperfect, a daily remission or alleviation of the fever may take place; and with it there is usually a deposit in the urine, of a pinker or lighter color than the

usual brown lateritious sediment, and containing, besides lithate of ammonia, purpurate of ammonia and lithate of soda.

Effusion (including adhesion).

449. Effusion we have already found to be a result of inflammation (§ 423); but it is not always, like resolution, a termination of this process (§ 427). An abundant effusion of liquor sanguinis, of coagulable lymph and serum, of pus, or of inflammatory mucus, usually lowers the inflammation—that is, reduces the determination of blood, and may diminish the obstruction, but often does not remove it; and the effused matter may cause sundry mischievous effects, by compressing, stuffing, or obstructing the several structures in which it accumulates. We may with advantage pursue the history of effusions, by tracing their changes in the chief elementary tissues.

Serous membranes, being simple in structure, give us the best illustration of the history of inflammatory effusion. In acute inflammation, in a healthy subject, besides serum, an exudation of fibrine or coagulable lymph takes place in a few hours. This fibrine is at first in a semifluid, ductile state; so that the motion or pressure of the inflamed surfaces draws it into bands or threads, and exhibits the same adhesive properties which were before noticed, as belonging to one of its elements, the pale corpuscles within the vessels (§ 417); or spreads it into films, as we see it on the pleura, pericardium, and peritoneum. But if we examine inflamed surfaces which are less exposed to motion or pressure, as the looser parts of the auricles of the heart, the serous covering of interlobar divisions of the lungs, that of the less projecting parts of the intestines, and of the convolutions of the brain, we find the deposit of lymph not uniform in a film, but in points forming a granular surface; which shows that either more is effused at some points than at others, or that the concretion of fibrine having begun in points, chiefly augments around the same points. The granules thus deposited vary in size, from that of a grain of sand to that of a millet-seed; but if the deposit increases, they enlarge into patches, which may run into one another, often forming a mammilated coating of lymph. Even on surfaces which are subject to motion, the prevalence of the fibrinous effusion at points is shown by a villous or shaggy appearance of the lymph, from this, in its ductile state, being drawn into threads projecting from the points where it has first concreted; this is sometimes well seen in the pericardium. In the pleura, these inequalities are more obliterated by the rubbing motion of respiration, or by the pressure of liquid effusion.

450. The lymph thus effused is (like the buffy coat of inflamed blood) at first transparent; afterwards it becomes yellowish, and more or less opaque, but in inflammation of a healthy subject generally retains some degree of translucency. In this respect, it contrasts with the product of inflammation in unhealthy subjects, purulent and tuberculous lymph, which is more opaque. But the most important character of healthy lymph is its high susceptibility of organization, which character I will in future designate by the term *euplastic* (§ 211). Euplastic lymph consists of fibrils of fibrine crossing each other in various ways, and mixed

with numerous exudation corpuscles, both compound (cells with nuclei and granules) and simple (granules and molecules). Now, these are also found in the buffy coat of inflamed blood (§ 212); and there can, therefore, be no doubt of their identity, and that the blood thus altered by the inflammatory process is their source (§ 438). This leads us to anticipate what is the fact, that the plasticity of lymph will depend much on the good quality of the blood, as well as on the energy of the inflammation. Healthy blood, which abounds in red particles as well as in fibrine, furnishes the most plastic kind of lymph (§ 183); and inflammation, attended with the most active determination of blood (so long as the integrity of the vessels is preserved), separates this lymph in the greatest abundance. This lymph already possesses living properties, for its materials arrange themselves into the basis of a texture; but to sustain the life of this texture, it must be supplied with blood, and this takes place in the wonderful process of the formation of bloodvessels in it, which communicate with those of the adjoining parts.

451. The precise manner in which vessels are formed in lymph is still a matter of some obscurity. Mr. Kiernan observed inflamed capillaries become varicose, and at points project in pouches and diverticula, and stretch into loops. If these give way, the blood would be injected into the lymph; and if something of channels were previously formed by the arrangement of the fibrils, or the elongation and communication of cells, it is quite conceivable that a current would be affected by the *vis à tergo* through several openings, and that a return of the blood would take place by a reversal of the weaker currents. Mr. Travers has observed a process somewhat resembling this take place; solitary red particles making their way into a bed of lymph-globules, and after for some time exhibiting an oscillating movement, give way to a current. The oscillatory movement most probably depends on the pulses of the heart, as in the case of those described to occur in obstructed vessels (§ 418). Vogel describes the formation of new vessels, and even of the blood within them, as productions of the blastema, independently of adjoining vessels; but were this observation exact, we might expect frequently to meet with the appearance of vessels with blood in detached masses of lymph, and throughout the thickness of large clots accumulating on serous membranes. It has been ascertained by Schrœder, Liston, and others, that the new vascular channels are at first much larger than the vessels which supply them; they are afterwards contracted by the formation of a basement-membrane lined with epithelium; and the whole texture becomes more consistent and less bulky, exhibiting a filamentous and cellular structure, with nucleated cells scattered through it. These new membranes form patches on, or adhesions between, the serous coverings of the lungs, the heart, and intestines; and provided these false membranes are loose, flexible, and of moderate thickness, that may cause no disorder.

452. When the inflammation is of a low character, or when the blood is poor in red particles, and especially when these two conditions are combined, the solid products of inflammation are less capable of organization, and therefore may be called *cacoplastic*. As the process of organization varies in degree, so these products may attain to different

degrees of structure, forming membranes of a denser, less pliant texture, and less vascular than the serous membranes to which they are attached, and which they therefore shackle. Thus patches of a kind of fibro-cellular or fibro-cartilaginous membrane are formed on the lungs, the heart and the intestines; sometimes with the effect of materially impeding the functions of these several organs. Where the effusion of lymph is scanty and slow, its granular mode of deposit is more obvious than in the more acute disease; for being less ductile, it is less readily spread or stretched by the motion of the parts (§ 449). This is well seen in chronic inflammations of the peritoneum and arachnoid, in which the deposit is almost entirely in granules or flattened patches, commonly called tubercles. These are generally of a buff or skin color, of firm consistence, and sometimes exhibit slight traces of bloodvessels in them;[1] but sometimes their color is more yellow and opaque, their texture uniform and tough, and they are totally destitute of vascularity. These constitute the formations described under the names cirrhosis and crude yellow tubercle, and are the lowest of the organized products. Being, in organization and consistency, dissimilar to the membranes on which they are formed, they prove a source of irritation and constriction; and being liable to ulterior changes (shrinking and contraction in the case of cirrhosis; farther degeneration and softening in the case of yellow tubercle), they may bring farther mischief in contiguous parts.

453. In some cases, again, more or less of the product of inflammation is *aplastic*, or totally incapable of organization, and is thrown off with the liquid in separate large globules filled with granules and molecules, constituting pus; or in detached opaque flakes or curds, consisting of aggregations of irregular granules, oil-globules, and molecules held together by a few fragments of fibrils; such effusions are exemplified in the sero-purulent liquid and curdy matter of low pleurisy, pericarditis, and peritonitis. It is obvious that such lifeless products must act prejudicially on the containing structures; and the fact might be anticipated that they are little susceptible of absorption.

454. I have mentioned (§ 452) a low form of inflammation, and an unhealthy condition of the blood, as causing the cacoplastic character of the products of inflammation. It may be added, that the long continuance of any inflammation, and its occurrence in subjects in whose blood fibrine abounds, while the red particles are scanty (§§ 185, 195), will pretty surely render the products cacoplastic or aplastic. At the onset of inflammation, its products may be plastic, and the process of vascular organization (§ 451) may commence; but if the inflammation continues, its product either is thrown beyond the reach of vascular communication, or displaces that already effused, and thus the outer layer will be in a degenerating condition. Added to this, the pressure

[1] Mr. Dalrymple has observed, that the vascularity of lymph may be seen earlier in cachectic and scorbutic subjects than in healthy lymph. But syphilis and scurvy may moderate inflammation, without rendering the lymph aplastic; the great impediments to organization of lymph are, its bad quality and excessive quantity, and the persistence of inflammation. In a scorbutic subject, Mr. D. has shown that even a large coagulum of blood may soon become vascular; but it does not follow that either this or lymph in such subjects can be formed into real texture.

of the liquid effusion may impede the construction and injection of the new membrane, which therefore is degraded into one of the cacoplastic or aplastic matters above described. Again, in scrofulous or cachectic subjects the blood, although scanty in red particles, abounds in fibrine, and this is readily effused in inflammation; but it is of low vitality, and susceptible of little or no organization.[1] There is yet another circumstance tending to lower the plasticity of lymph, although, according to the observation of Mr. Dalrymple, it sometimes accelerates its organization[2]—that is, the admixture of the coloring matter of the blood with it. Lænnec supposed that contraction of the chest had its origin in hemorrhagic pleurisy only. This is not correct; but I have many times remarked after death, that lymph on the pleura and pericardium, in cachectic subjects, is much stained with blood; and where patients with similar symptoms have recovered from inflammation, they have been affected with structural disease. So far as we yet know, the coloring matter does not form a material for organization; and farther, it is very probable that in such cases the coloring matter is itself diseased (§ 186).

455. The more complex structure and secreting properties of *mucous membranes* considerably modify the form and appearance of the products of their inflammation. But, according to Gerber, Henle, and Gruby, they microscopically consist of pus and mucous globules, granular cells, granules, and molecules, together with more or less amorphous and glutinous mucus and scales of epithelium. I must add, however, that in the early stage serum is present, manifest by the saline taste and coagulability by heat; and at an advanced stage, the mucus acquires an increase of fatty matter.

Irritation of mucous membranes merely causes a flux (§ 379), that is, the natural mucous secretion; more copious, watery, and saline than usual, and containing fewer globules. But if the irritation be continued, and inflammation follows, the secretion is at first diminished by the effusion of serum and pale corpuscles into the interstices of the mucous and submucous texture, which causes more or less thickening or swelling. Soon, however, the effusion overflows to the surface, in the form of a more or less viscid, saline-tasted liquid, containing more globules and epithelium scales;[1] and as the inflammation becomes more intense, the globules predominate, and the mucus becomes more scanty, but it is still very viscid. On the first decline of the inflammation, the mucous and saline matters diminish, and the globules compose the chief mass of the secretion, and give it the yellowish or greenish opacity seen in "concocted" sputa; and this opaque matter is afterwards gradually replaced

[1] When a coagulum of fibrine is retained long in a vessel without becoming organized, it loses its structure, and softens into an opaque semifluid matter, which long was mistaken for pus; but Mr. Gulliver has shown that it consists of much smaller particles, mere irregular granules. In this state it bears the closest general and microscopical resemblance to mature and softened tuberculous matter. It appears to me, that certain softened tuberculous appearances, met with in the lymph of serous membranes and parenchymata, are similar in their nature.

[2] Medico-Chirurg. Trans. 1840, p. 212.

[3] Gruby; Morphology of the Pathological Fluids. Translated by Dr. Goodfellow (*Microscopical Journal,* Nos. 19–23).

by the natural mucous secretion. In many cases, especially in young subjects, and others in whom the inflammation penetrates to the submucous cellular texture, fibrinous matter is thrown out, forming films or shreds of lymph, or giving a fibrous or filamentous appearance to the mucus; but this fibrine very rarely becomes organized on mucous membranes, because their secreting apparatus and its product lie between the lymph effused and the vascular structure. Hence the exudation corpuscles of inflammatory mucus are degenerating or aplastic, and constitute the opacity of viscid mucous, muco-purulent, and shreddy fibrinous matters exuded by inflamed mucous membrane. If inflammation persists in a mucous membrane, the globules continue to abound in the effusion, commonly rendering it opaque and purulent; and the natural mucous secretion being impaired, the product is more diffluent. But inflammation rarely continues long over a great extent of surface; it is confined to patches, which yield their opaque effusion whilst other parts may be secreting natural mucus. Hence the compound appearance of the secretions in chronic inflammations of mucous membranes (bronchitis, mucous enteritis, and cystitis).

Sometimes, interstitial effusion, which takes place at the commencement of inflammation of mucous membrane, is not entirely removed by the subsequent discharge. In such cases, there may remain a permanent thickening of the mucous and submucous texture, which is the cause of the indurations and strictures which inflammation sometimes leaves in the intestines and urethra; and, to a less degree, in the air-passages. This, however, it must be observed, is the result of inflammation, rather of the submucous cellular texture than of the mucous membrane itself.

456. Inflammation of the *skin* presents great varieties as to the amount and kind of its products. The full consideration of these would lead us into the pathology of skin diseases, a subject replete with interest and practical importance, although sadly neglected amidst the artificial distinctions of writers on cutaneous diseases; but the subject is too wide to be discussed here.

Some of the effusions in and from the skin have been glanced at under the head of the symptoms of inflammation (§ 432). It may now be added that these effusions may consist of clear serum, with few exudation corpuscles and molecules, as in the liquid of blisters and blebs, and eczema, which dries into thin scabs; or of milky serum, more abounding in the corpuscles, which dry into thicker scabs, as in herpes, rupia semplex, &c.; or of liquor sanguinis and purulent serum, with more numerous corpuscles, which form very thick, yellow, or brown scabs, as in rupia prominens, impetigo, and ecthyma; or the effusions may be chiefly solid, and into the substance of the dermis, as in tubercular inflammations and incipient pustules. In all cases of inflammation of the skin, there is an increased production of epidermis, which is sometimes thrown off in scales, with the scabs; or in a peeling of the cuticle; or thickens, and forms a hard covering, liable to clefts and sore ulcerations, as in psoriasis, inveterate eczema, &c.

457. Inflammatory effusion into the *cellular texture* consists of serum, with more or less of the exudation corpuscles and fibrine. In diffuse erysipelas, or cellulitis, the fibrine is deficient, and the corpuscles either

are in moderate numbers, or else are degenerative (purulent). In phlegmonous inflammation there is more fibrine, which circumscribes the effusion, and causes a harder swelling; and the pressure of this, with a continuance of inflammation, may lead to suppuration or sloughing.

458. Effusions from inflammation of *parenchymatous organs* resemble those from inflammation of cellular texture; but the parenchymata in general being very vascular, as well as yielding, the solid effusion may be very copious, without causing the pressure or tension that leads to suppuration and gangrene. The lymph effused exhibits, in regard to plasticity, the same varieties which we have described in the products of serous membranes (§ 450, *et seq*). But inasmuch as lymph effused in the parenchyma of an organ would greatly interfere with its function we rarely find it to become organized, except in limited portions, which thus remain solid and dense. More usually, the matter deposited is gradually removed by absorption or secretion after the inflammation declines; or, if the inflammation continues, the exudation globules and lymph are converted into, or replaced by, various kinds of pus or tuberculous matter—consisting of degenerated corpuscles, granules, and fat-globules.

459. Effusion so closely attends the process of inflammation, that the *symptoms* of effusion have been comprehended in those of inflammation. Swelling, pressure, obstruction, irritation, consolidation, displacement, and various functional as well as structural disorders, may arise from the presence of effused matter. Hence the occurrence of effusion may aggravate some of the symptoms of inflammation, whilst others may be more or less relieved by it. Where a copious effusion takes place, the pain, heat, redness, and fever are commonly reduced; for the vascular and nervous excitement and determination of blood are lessened; but the local or visceral disorder may be increased. The pulse may be as frequent, but it is less hard and full; the fever less constant, but it may continue in a lower degree, or assume a remittent or hectic form. The relief by effusion is greatest in slight inflammations, or where the effused matter can be thrown off from the body, as in the case of mucous membranes; but there may be much irritation and exhaustion of strength in the process of throwing it off (as in cough and expectoration, diarrhœa, purulent micturition, &c.); and these will be more harassing where, as we have found is sometimes the case, the effusion does not remove the inflammation.

Suppuration and Ulceration.

460. The formation of pus among the products of inflammation has been several times noticed (§§ 424, 453, 455, 457, 458). Pus is an opaque greenish or yellowish white liquid, of creamy consistence, little odor, of specific gravity varying from 1030 to 1033. It is chemically composed of water, deutoxide of proteine forming the cell-walls, tritoxide of proteine and albumen in solution, fat, osmazome, and other extractive matter, and the same salts as those in the blood. According to Gerber, mature pus contains more fat and less albumen than that recently formed.

Microscopically, pus consists of a limpid serum, and very numerous

globules of pretty regular size and form. These globules have much resemblance to granular cells or exudation corpuscles; but they are larger and more distinctly and constantly provided with a cell-wall and nucleus, in addition to granules and molecules. Vogel describes their form to be in general spherical; but sometimes irregularly rounded or oval; their cell-wall is commonly opaque and somewhat uneven from being studded with minute granules. Acetic acid renders the walls transparent, and brings into view their nucleus, which, under the action of the acid, takes the form of from one to five somewhat elliptic disk-shaped bodies, clustered and attached to the interior of the cell. The existence of the cell, in most pus-globules, is also made clear by the action of distilled water, which causes the cell to dilate (by endosmosis) to double its former size; and the larger granules or nuclei swell also, which shows their vesicular nature. Pus-globules are larger than the general size of exudation corpuscles (§ 424), and exceed in size the blood-disks (Gulliver). According to Mr. Addison, they measure from $\frac{1}{2000}$ to $\frac{1}{1500}$ of an inch.[1] Besides, in size, they commonly differ from other exudation corpuscles in being more distinctly vesicular, and containing a fluid as well as granules; their more readily swelling, bursting, and shedding their contents under the influence of water or potass (Addison), may be referred to the same difference. In some instances, Vogel admits pus-globules to be devoid of a distinct cell-wall, as I have stated to be the case with some white or granular corpuscles; and the only distinction of this kind of pus corpuscle, is in its exhibiting the peculiar trefoil or cordiform nucleus under the action of acetic acid.

461. Another distinguishing character of the pus-globules is their want of cohesion; and in proportion as they predominate, they impair the consistence of fibrine or mucus with which they may be combined. In this respect they contrast remarkably with the white corpuscles, which both within and without the bloodvessels we have noticed to manifest a remarkably adhesive and cohesive property. This and the other differences may be explained on the supposition of the more gelatinous or semisolid parts of the white corpuscle becoming completely fluid, whilst the cyst becomes more solid and tougher than before; such a change would account for the vesicular form and incohesive properties of the globules of pus; and the extension of a similar change to the larger of the contained granules, would equally convert them into minute cells, which have the appearance of nuclei, with the usual endosmotic properties. This liquefaction accompanying the formation of pus, is not confined to the contents of the pus-globule, nor even to the lymph and other products of inflammation; it extends to the containing vessels and textures, which are softened, disintegrated, and removed, in proportion as the suppurative process proceeds. In complex textures, therefore, whence the pus cannot escape, this process consists not merely in the formation of pus, but also in its substitution for more or less of the inflamed texture; for this reason suppuration, more than effusion, may

[1] Pus is not produced in birds, or in cold-blooded animals; the reason of this is not understood, as the exudation corpuscles do not materially differ from those of mammalia. A careful investigation of the products of inflammation in birds as well as in quadrupeds, would probably throw much light on the true nature of pus and lymph.

be called a termination of inflammation, for the inflamed vessels are in great part destroyed.

The chemical change which accompanies and probably causes this disintegration and liquefaction in the formation of pus, according to the researches of Mulder, seems to be an increased oxidation of the proteine, whereby it passes from the state of solid deutoxide to that of tritoxide, which is readily soluble in water or serum. But this farther oxidation and solution implies also a reduction of vitality in the exuded corpuscles, which thus lose their organizing power, and degenerate into a loose aplastic material. We shall find that the circumstances which promote suppuration, the nature of the process, and the symptoms which accompany it, exactly correspond with this view of the subject.

462. The circumstances which determine suppuration as a result of inflammation, are chiefly three: 1. A certain intensity and duration of the inflammation; 2. The excess of air to the part; 3. A peculiar condition of the blood.

1. Intensity and continuance of inflammation comprise the persistence of the two chief elements of the process, determination of blood and obstruction (§ 419); and as we have found that the physico-chemical effect of this is first to direct the force and exaggerate the influence of the red particles which convey oxygen, on the liquor sanguinis, so that more of its proteine passes into the state of solid deutoxide; a material fitted for organization and reparation;—so we may infer that the excessive degree or continuance of the same process may overdo the change, give chemical properties an ascendency over the vital powers; and by turning the most recently formed solid into a fluid tritoxide, it may effect a work of separation and destruction which may involve the blood in the obstructed vessels, and extend to the albuminous matter of the containing living texture. Such a result is more likely to ensue in complex and highly vascular structures, in which the effused matter is retained in intimate contact with the bloodvessels; hence intensity and continuance of inflammation pretty surely lead to suppuration in the true skin, cellular textures, glands, and most parenchymatous organs. In serious and fibrous membranes, on the other hand, suppuration is a rarer result because the vessels are few, and the effused corpuscles less within their influence. In partial external inflammations, suppuration may often be prevented by pressure, which diminishes the determination of blood, and therefore reduces oxygenating influence.

2. The access of air to a wound or to a serous membrane is well known to promote the formation of pus; and it doubtless chiefly acts by directly supplying oxygen, and converting the fibrine and part of the exudation corpuscles into the soluble tritoxide of proteine; but air may also operate as an irritant on a serous membrane or abraded surface, increasing the intensity of the inflammation. A limited access of air to a large quantity of pus leads to a decomposition of the matter and the production of sulphuretted hydrogen, which acts as a deleterious poison on living structures.

3. That a peculiar condition of the blood promotes the occurrence of suppuration after inflammation is obvious from the readiness with which all wounds, scratches, and pimples fester, and inflammations of no

peculiar intensity and in various structures early lead to the formation of pus. This state of the system has been called the *suppurative diathesis*, and is presented in cachectic or ill-conditioned subjects, the quality of whose blood has been injured by malnutrition, imperfect excretion (§§ 171, 187), or by the direct operation of some morbid poison (§§ 258, 296) such as that of erysipelas, confluent smallpox, glanders, &c. But the most efficient cause of the suppurative diathesis is the abundant presence of pus itself in the blood (pyæmia), as in cases of phlebitis, diffused suppuration, &c.; and it is most probable that this cause really exists in the examples above mentioned; for Mr. Gulliver and others have detected pus-globules in the blood in many such cases; and there is good ground to suppose that in all cases of suppuration some of the granular corpuscles are converted into pus-globules within as well as without the vessels; but, for reasons that will afterwards be explained, this takes place only to a very limited extent under ordinary circumstances. The conversion of the white or exudation corpuscle into the pus-globule always implies a loss of vitality; and therefore a peculiar proneness to the change (independently of intensity of inflammation and exposure to air) indicates a feeble state of the vital powers, which are unequal to resist chemical affinities. In extreme cases this tendency shows itself by the occurrence of gangrene, which often supervenes in the worst form of pyæmia, as in malignant erysipelas and glanders. It is therefore, quite intelligible that pus, either in a part, or in the blood at large, may act in the mode of a chemical ferment, promoting the formation of more, and tending to degrade the plasma of the blood from that organizable condition in which it can repair breaches or sustain the nourishment of the body.

These considerations will throw much light on the farther process and symptoms of suppuration.

463. The process of suppuration strongly illustrates the opposite character of the elements of inflammation before alluded to (§ 421). The obstruction to the passage of the blood through the capillary vessels of an inflamed part, and the increase of this obstruction by the pressure of matter effused by those vessels that are the seat of determination, reduce the vitality of the tissues to so low a degree, that they are unable to withstand the chemical solvent power of the effused fluids,[1] exalted as it is by high temperature. The textures are therefore gradually disintegrated, dissolved,[2] and absorbed away, whilst the exudation corpuscles, swelling into pus-globules, occupy their place, and continue to be effused and developed by the vessels which are still the seat of determination of blood.[3]

[1] That the liquid of pus can chemically dissolve dead animal matter was proved by J. Hunter, who found that pieces of raw meat were dissolved in abscesses, or even in pus kept warm out of the body. The experiments of Sir C. Wintringham show that other animal fluids have a like property. Dr. Prout notices similar facts. This solvent property we have now reason to ascribe chiefly to the formation of the soluble tritoxide of proteine. A similar change takes place during the cooking of meat; so that the old expression *concoted matter* is not altogether metaphorical.

[2] The idea that the removal of textures in suppuration is owing to their death, originated with Dr. Billing. (See his *Principles of Medicine.*)

[3] That absorption is increased in an inflamed part is farther proved by a direct observation of Kaltenbrunner, who watched the gradual disappearance of the pigment spots in

This assumes that absorption is still active in an inflamed part; and the assumption is warranted by the fact that the absorbing vessels, veins, and lacteals remain perfectly free; and the very occurrence of increased pulsation and flow in communicating and contiguous vessels (§ 413), will promote the exosmosis of fluid matter by the absorbent vessels. That the pus-globules should remain unabsorbed will not appear extraordinary, when their large size is taken into account (§ 460), and that their cysts are not dissolved by their proper fluid, having acquired a remarkable degree of toughness. Their large size is wholly opposed to the notion that they are effused from the bloodvessels as pus-globules; but their arising from the exudation corpuscles easily accounts for their appearance in the midst of lymph, and other products of inflammation, which they supersede as they enlarge and multiply. Thus the combination of apparently opposite results, which has been considered so inexplicable—excited and lowered action, increased secretion and increased absorption—admits of an explanation in exact accordance with all the phenomena.

464. The amount and extent of the process of suppuration varies in different cases. In cellular and parenchymatous textures, it sometimes occurs as *purulent infiltration*, not circumscribed by lymph, but leaving the texture much softened, and partially removed. This diffused kind of suppuration is to be referred, either to the porous nature of the organ (as with the lungs) not admitting an effusion of lymph sufficient to limit the suppuration, or to a purulent diathesis or disposition in the blood (§ 462). In most cases, the process of suppuration is limited around by solid effusion, which may be either the remains of the earlier product of the inflammation, or it may be thrown out expressly for the purpose of defending the adjoining structure from the operation of the pus, which is obviously a noxious matter. A collection of pus thus circumscribed is called an *abscess;* and when mature, it represents the perfection of suppuration. The bloodvessels of the inflamed part are destroyed like other textures; but their supplying trunks are obstructed by lymph; whilst the adjoining capillaries, which remain pervious, become dilated and varicose on the wall of the abscess, which are lined with a coating of organized lymph, the vessels in which continue to secrete pus; whence this lining is called *pyogenic* membrane. As the pus increases, the abscess becomes enlarged, generally towards some cutaneous or mucous surface where it is said to *point;* the skin or membrane ulcerates, and the pus is discharged. The direction which the abscess takes, seems to be that in which there is least resistance; the parts here are more stretched than others; and from being stretched, their vessels are more obstructed, so that they cannot maintain the vitality, nor throw out the same amount of protecting lymph, which limits the extension of the abscess in other directions. Fibrous and other hard textures resist the progress of abscesses, and the escape of pus. Serous membranes, by their ready plastic process, first adhere together, and then often give passage to the contents of an abscess through them, without any pus escaping into their

the frog's web. This, however, was not suppuration, as that process does not occur in cold-blooded animals.

sac. Thus, abscesses of the liver and kidney make their way across the peritoneum into the intestines, through the walls of the abdomen, and even through the diaphragm, pleura, and lungs. Where pus from an abscess does make its way into a serous sac, it causes severe irritation, and, commonly, fatal inflammation.

465. After an abscess has opened, it may continue to discharge pus, pure, or diluted with serum or sanies; but in healthy subjects, a process of healing takes place by an increased effusion of lymph, and growth of new vessels in it, in the form of *granulations*, throughout the interior of the abscess. Pus is still formed by the superficial layer of exudation corpuscles degenerating or swelling; and a free vent must be given to this pus, until the growth of the granulations, and the contraction of the walls, shall have obliterated the cavity of the abscess, and left no more room for the pus to accumulate.

466. *Ulcers* sometimes arise from abscesses; an abscess that has discharged its contents is, in fact, an ulcer. But more commonly, ulcers originate from limited inflammations of the skin or mucous membranes, in which the natural cohesion of the skin is so much impaired by the solvent action of the effusions on the tissue, that it is broken up at one or more spots, and either carried away in the pus discharged, or absorbed. There is then left a solution of continuity or excavation, the bottom and edges of which continue to discharge pus, or a serous fluid, mixed with exudation corpuscles, and, sometimes, blood-particles. Ulcers may tend to spread by the same process; or to heal by the effusion of fibrine on their walls, and the extension of vessels into this lymph in the form of granulations, which are the materials of the new texture. Ulcers, besides, present a great diversity of character in the nature of their secretion, and the condition of their walls, as well as in the symptoms which they produce; these circumstances constitute the varieties of ulcers described in surgical works.

The cause of ulceration is commonly local, the inflammation suspending the normal nutrition of a part, and promoting its solution (§ 460, 3). It is often preceded by induration from the amount of solid deposit; and the ulceration commences in the centre of the induration, because the nutrient influence of the vessels is most reduced by the pressure at that spot. But a very poor condition of the blood (hypinosis, § 196) is often much concerned in determining this result, and seems to be sometimes sufficient to cause ulceration, without any distinct previous induration, or even inflammation; the parts that suffer being either those which have become congested by posture (as in cachectic ulcerations of the legs), or those most remote from the nourishing influence of the blood; such as the non-vascular textures, the cornea, cellular parts of cartilages, &c. In cases of extreme anæmia (§ 268), where the fibrine and albumen of the blood are very defective (§ 197), ulcers of this description arise, and are to be counteracted by measures the very opposite to antiphlogistic. A similar result was found, by Magendie, to ensue in animals fed on sugar, starch, and other non-azotized articles of food. In these instances, the ulceration and destruction of textures may be referred to prevalence of the solvent power exerted by the oxygen of the blood on materials whose vital power of resistance (§ 16) is much

reduced, and for which there is no renovating supply in the plasma of the blood.

467. *Softening* of textures may arise from the same change which, in a greater degree, and more circumscribed space, causes ulceration. It has already been noticed as an effect of inflammation (§ 427); and it may now be added, that the condition of the blood which disposes to ulceration sometimes leads to the more diffused operation of the same change in the softening of textures. Thus softening of the brain, liver, muscle, and mucous membrane, sometimes results from anæmia, or imperfect supply of blood in these parts, or from spanœnia or impoverished condition of that blood (§ 197); and inflammation, which farther impairs or deranges the supply, may immediately determine the softening process.

Local Symptoms of Suppuration.

468. It may be gathered from the previous description, that suppuration is a work of destruction, and therefore is, in some measure, to be contrasted with effusion of lymph, which is intended to be a process of construction or reparation. Pus is totally aplastic itself; it is formed at the expense of the plastic product of the vessels, and the liquid of pus seems to act as a solvent or septic on textures when their vitality is reduced. Although, therefore, suppuration is often useful in terminating inflammation, and in removing superfluous products and parts injured by it or its causes, yet suppuration must be viewed as a depressing and exhausting process, and its product as having a noxious character; the symptoms which accompany it will be found to correspond with this view.

469. The occurrence of suppuration is marked by a diminution of the heat, pain, and other signs of irritation and increased action in the part. The pain often becomes throbbing, as if the external pressure on some of the larger vessels had yielded, and these become expanded at each pulse. The swelling becomes softer; and if within the reach of touch, is felt to be first more yielding under the finger, and afterwards to present the fluctuation of fluid matter. The redness present in inflammation is also diminished, being wholly superseded by the pale yellow of purulent effusion in the central parts of the suppurating mass, being mottled by it in others; and retaining its deep character only in those parts of the circumference where the suppuration has not reached. In external inflammations, the redness of the skin becomes deeper before suppuration; but when this process reaches the skin, a pale spot is seen, which, by its fluctuating feel, indicates the approach of the abscess to the surface.

The great reason of the alleviation of the symptoms of inflammation, on the occurrence of suppuration, is the diminution of tension and hard swelling, which chiefly cause the pain and irritation (433); and where suppuration takes place amidst unyielding parts, as under a fascia or within a bone, the tension is increased rather than lessened, and the symptoms of pain and irritation may be more severe than ever. The powerful influence of hydraulic pressure in causing the injection of a liquid into a compact texture, and the swelling of the pus-globules by

endosmosis after their first formation, will assist in explaining the effusion of pus under a dense periosteum, or theca, and the extreme pain and irritation which it produces. The free secretion of pus from mucous membranes relieves inflammation, and removes the submucous deposit (§ 455).

General Symptoms of Suppuration.

470. The influence of suppuration on the system is manifest in the lowering of the inflammatory fever; the pulse losing its strength, but retaining its frequency; the heat subsiding, or alternating with chills and sweats; the general redness being succeeded by paleness, or a hectic flush; the urine depositing a pale or pinkish sediment;[1] and the general excitement giving place to weakness and exhaustion. The amount of the change will greatly depend on the extent of the suppuration, and the importance of the organ affected; but another chief circumstance determining the effect of suppuration, and proving the noxious influence of pus on the system, is the difference between those suppurations that are diffused without a circumscribing barrier of lymph, and those that are thus limited, or are thrown off at once from the body.

In some cases of inflammation of the cellular texture, skin, and of serous membranes, pus is formed with little or no previous exudation of lymph, and produces in the system the most formidable effects. The pulse becomes very frequent and weak; the tongue brown and dry, or coated with an offensive fur, and tremulous; sweats break out profusely; the urine is scanty, high-colored, and fetid, sometimes it is suppressed; a putrid diarrhœa occasionally occurs; hiccough comes on; the mind is much depressed, or excited by occasional delirium; the patient's manner and motions are agitated and restless; the breathing becomes hurried and sighing; and death may ensue in from one to four days from the commencement of these symptoms. Similar results ensue in suppurative inflammation of veins; and in injuries of the head ending in suppuration, communicating with some of the venous sinuses; and they have been known to follow where an external abscess has suddenly subsided without opening, and in cases in which the discharge from a large suppurating wound has suddenly ceased. On opening the body after death, in a few such cases, nothing peculiar has been found, except a general fluidity of the blood, and the gravitative congestions and stains which that fluidity induces (§ 196). In most instances, however, there are found in some of the viscera, particularly the lungs and liver, *purulent deposits*, as they are called; collections of pus, generally confined to lobules or portions of lobes of these viscera, with more or less inflammatory injection and deposition of lymph around the collections. In these cases there can be little doubt that pus in some way is conveyed in the circulation; and being arrested in the lungs and liver, leads to the formation of more (§ 462)—whether by the production of suppurative

[1] The occurrence of urinary sediments after suppuration has been noticed by Schonlein as a constant phenomena; but such sediments are also observed after inflammation without suppuration, and must be regarded as the debris of plastic matter and textures *wasted* during the inflammatory process.

phlebitis, as supposed by Cruveilhier, Dance, and others, is doubtful—and that the pus in the blood is the cause of the formidable symptoms and results above noticed. In several such cases purulent matter has been detected in the blood in considerable quantities, not only by the aid of the microscope, but by the pus-globules forming a visible layer on the surface of the red particles. From the experiments of M. D'Arcet,[1] it is probable that the poisonous influence of purulent matter arises from chemical changes induced by air in its serosity (§ 460); but that obstruction to the circulation in the lungs and liver, and consequent circumscribed inflammations of these organs, result from aggregation of masses of the debris of the globules of pus contained in the blood.

In those instances of the abundant presence of pus in the blood, it is not to be supposed that it is absorbed through the entire walls of blood-vessels; the large size of the pus-globule, as before noticed (§ 463), forbids that supposition; but unusual channels of entry into the vessels have been in several cases discovered, as in the instance above mentioned of an abscess in the skull opening into one of the sinuses; to which may be added that in suppuration in bones generally, the pus may may find entrance through the open venous canals; and in wounds of the neck it may be drawn in through the large divided veins under the suction influence of inspiration. Suppurative phlebitis has been already mentioned as an obvious cause of pyæmia. Lastly, we must again advert to the fact, first established by Mr. Gulliver, that pus-globules appear in the blood in other cases of severe inflammation and suppuration where no opening into the veins is known to exist. In these instances, as before stated (§ 463), the pus-globules are probably formed within the vessels of the inflamed part; and these increase and produce symptoms of pyæmia only in cases in which the vitality of the blood is impaired, and there is a proneness to the formation of pus from trivial causes (§ 462). To the latter group I would refer several instances of pyæmia with the bad symptoms before mentioned, which I have seen after scarlatina, and in a few cases of acute albuminuria and typhoid rheumatic fever. Probably, too, malignant erysipelas and metroperitonitis belong to this class.

471. The preceding observations prepare us for the fact that, besides the extreme effects above noticed, extensive local suppurations cause various symptoms of depression or low irritation. Of this kind are the rigors often experienced at the commencement or increase of suppuration. Dr. Billing plausibly ascribes this to the system sympathizing at the death of the part which is under destruction by the suppurating process; but the rigor not being always present suggests rather that the presence of a certain amount of pus in the blood might be its cause; and this may induce the shivering merely as a depressing agent, or very probably by directly interrupting the calorific process by the withdrawal of a portion of the oxygen which sustains it (§ 461). This latter notion is countenanced by the remarkable and sudden fall of temperature which often accompanies the extensive formation of pus.

[1] "Recherches sur les Abscès Multiples," &c.; and Brit. and For. Med. Rev. Jan. 1843.

Again, when suppuration continues long, even if it be discharged outwardly, as in extensive wounds, or ulcerations of the skin or mucous membranes, there is great wasting of strength and flesh, with a partial febrile irritation of a peculiar kind, called *hectic fever*. This is remittent in its symptoms, the exacerbations recurring once or twice daily, beginning with chills and depression, and followed by frequent pulse, partial heats, especially of the cheeks, hands, and feet, and ending in a profuse perspiration. As this proceeds, the body more or less rapidly wastes; and the colliquative sweats and diarrhœa, vomiting, and aphthæ of the mouth, are so many proofs of the rapid decomposition and removal of the various structures, which tend to hasten the fatal result. The febrile part of hectic is most observed in the young and irritable; but the depressing and exhausting effect of extensive suppuration is seen in all cases, in progressive emaciation and cachectic pallidity.

472. The matter of abscesses is *laudable* or healthy in proportion as it is thick and opaque, but uniformly liquid and free from smell; for although, even in this state, it is fit only to be expelled from the body, and is prone to decomposition, yet if excluded from the air it will remain unaltered for a long time. The formation of such pus is pretty sure to be attended with a protection of lymph, and it is far less noxious than ill-conditioned sanious matter, the fetor of which indicates that decomposition has already begun.

GANGRENE.

473. *Gangrene*, like the more complete forms of suppuration, may be well called a termination of inflammation, for the inflammation ends in the death of the part. In suppuration, the dying textures are softened and displaced by pus as fast as they die; in gangrene, the textures die more extensively than pus is formed, and they run into decomposition without being removed. In some cases, especially in limited gangrene, the dead portion is dissolved away at its circumference by the inflammatory exudation from the living parts, and it is thus separated or *sloughed* from them; but if the dead portion be extensive, and the power of the living parts low, the separating process will not be accomplished before decomposition ensues, which produces the changes called *gangrene* and *sphacelus*.

474. The circumstances which cause inflammation to terminate in gangrene are those which completely suspend the circulation of the part (§ 273), and those which greatly injure the composition of the blood or directly destroy vital properties. The circulation in a part may be destroyed by long-continued pressure, by severe contusion, laceration, or other mechanical injury, by extreme heat or cold, by strong chemical agents, by the excessive pressure of the solid matter effused in the early stage of inflammation (as in carbuncle), and even by an extreme amount of congestion.[1] The occurrence of gangrene is favored by extreme

[1] Two cases of gangrene of the lung which have occurred in my practice seemed referable to this cause.

weakness of the heart, the great moving power of the circulation; and the failure is most manifest in parts most remote from the heart, as in various structural diseases of the organ, in low fevers, and states of extreme exhaustion. It is favored by ossification or partial obstructions of the supplying arteries, which, although adequate to maintain the ordinary nutrition of the part, cannot dilate to supply the demand increased by any injury or irritation of the part. The agents which cause gangrene, by a directly destructive operation on the vital properties of the solids and fluids of the body, are various strong poisons, such as arsenic, sulphuretted hydrogen, the poison of the rattlesnake and other venomous animals, the poison of the plague, malignant scarlatina, smallpox, and erysipelas, hospital gangrene, glanders, &c.

475. An external part becoming gangrenous loses all feeling and other vital properties; its color becomes livid, or leaden, greenish, or almost black, the cuticle rises in blisters on it, and begins to exhale an offensive odor. The rapidity of this change will depend much on the moisture and warmth derived from the adjoining living parts; in *dry gangrene*, the dead portion becoming horny and black instead of putrefying. For the converse reason, in internal parts the progress of decomposition is more rapid. The putrid matter affects the living body (like many animal poisons) as a local irritant, and a general sedative or depressing agent; and the symptoms will vary much as one or the other of these two operations predominates.

In persons of robust constitution, active vascular system (§§ 112, 120), and good blood (§ 195), a dead part arouses active inflammation and effusion of lymph in the surrounding living parts, which may protect the system more or less completely from the infection of the dead matter. In such cases, although gangrene be present, the predominant symptoms may be those of inflammation and inflammatory fever. But living parts, with all their activity, cannot long withstand the pernicious influence of dead matter; so that if this matter be not soon thrown off in the form of a slough (§ 473), or liquefied in the inflammatory exudations poured out, the system becomes infected, and suffers from its poisoning and prostrating operation. This will happen more surely and early, where the dead part is in the interior of the body, of great extent, surrounded by vascular texture, and with its decomposition promoted by the warmth and moisture. In subjects of weak constitution, feeble vascular system, and blood defective in plastic matter (§ 196), the irritation of dead matter may fail to excite a protective (adhesive or plastic) inflammation, and the putrid or typhoid symptoms then show themselves earlier, and prove more speedily fatal. These symptoms are—increasing feebleness and frequency of the pulse, reduction of the fever, collapse and extreme pallidity of the countenance, cold sweats, brown, dry, or clammy foul tongue, low delirium, or restlessness and agitation of manner, hiccough, fetid diarrhœa, urine very offensive or suppressed, coma or syncope, and death. In external parts, or those which communicate with the surface, the putrid odor of the gangrenous part becomes a distinguishing physical sign; in gangrene of the lungs it is communicated to the expectoration and breath; in other cases, the whole body exhales a fetid odor.

The supervention of gangrene sometimes terminates the pain and other severe symptoms of the preceding inflammation, and this induces a false calm; but they are often replaced by distressing symptoms of nervous irritation, which subside only with the collapse of death.

476. In concluding this account of the results or terminations of inflammation, I must repeat what was said at the beginning (§ 445), that they rarely occur quite separately one from another, and in many instances they are all combined in different portions of an inflamed organ or texture. Thus, resolution is always attended with some amount of effusion; lymph often has the color, opacity, and much of the microscopic character of pus; suppuration is almost always preceded and generally accompanied by the effusion of some lymph; and often abscesses are attended with gangrene and sloughing of parts; and these combinations are farther illustrated by the terms, *purulent lymph*, *flaky pus*, *sloughing ulcer*, *gangrenous abscess*, &c., which pathologists are obliged to employ to describe what they meet with.

VARIETIES OF INFLAMMATION.

Inflammation may vary in consequence of the predominance or defect of some of its elements or results, or from its combination with some of the other elements of disease previously considered. Or inflammation may derive a peculiar character from the nature of its exciting cause, which is exemplified in what are called *specific* inflammations. The following varieties demand a brief notice: *sthenic and asthenic; acute, subacute, and chronic; congestive; phlegmonous; erysipelatous; pellicular, or diphtheritic; hemorrhagic;* and *scrofulous*. Of the specific inflammations, the *gouty* and *rheumatic*, *syphilitic* and *gonorrhœal*, will be merely alluded to.

477. The varieties of inflammation, termed *sthenic* and *asthenic*, correspond with the parallel varieties of plethora (§ 279), hemorrhage (§ 360), and flux (§ 393), and are referable to a difference in the strength and irritability of the heart and arteries (§§ 110, 120, &c). Thus *sthenic* inflammation is marked by a strong hard pulse, high fever (§ 442), very fibrinous blood (§§ 208, 438), a full and active development of the chief symptoms or inflammation (§ 429), and a tendency generally to the more plastic products (§ 450). Patients affected with sthenic inflammation require and bear a greater amount of antiphlogistic treatment; and in them, if used in time, it is commonly most successful; for sthenic inflammation occurs in those of the most robust constitution, in whom the effects of disease are most readily shaken off.

Asthenic inflammation occurs in persons, the tone and real strength of whose vascular system is low (§§ 116, 123), and their blood (generally speaking) poor (§ 207). The pulse is not always affected; when it is affected, it is in frequency, more than in strength or firmness; the fever, if there be any, is of a slight remittent, or low character (§ 442, &c.). The products are either scanty, or of a cacoplastic or aplastic character

(§ 451); or the effusion may be chiefly watery, the inflammation differing little from flux and dropsy.

478. The terms *acute*, *subacute*, and *chronic*, applied to inflammation, properly relate to its duration; but they are often used in the sense which I have given to sthenic and asthenic. *Acute* inflammation may be, and commonly is, sthenic; but it is by no means always so; its distinctive character is, that it tends to a speedy termination of some kind or other. It may end in resolution, effusion, suppuration, or gangrene, in a period varying from a few days to three weeks. An inflammation lasting above the latter period is *subacute*, and if protracted beyond six weeks is properly called *chronic*. Very commonly, inflammation is acute, because it is severe or sthenic, its intensity leading to a speedy result; but asthenic inflammation is often also short in its duration; whilst chronic inflammation sometimes presents a good deal of the sthenic character (§ 477). Acute inflammation, when at all extensive, is attended with considerable fever and constitutional disorder. With subacute inflammation, the fever is less, and may even be absent. In chronic inflammation there is rarely fever; when present, it is of a remittent or hectic kind (§§ 444, 471).

The products of acute inflammation are commonly so copious as to be distinct in their character, being coagulable lymph, pus, inflammatory mucus, &c. In subacute inflammation they are often intermediate, such as purulent lymph, curdy matter, and tubercle in some of its forms. As with asthenic inflammation, the more they are in quantity, the less likely are they to become well organized.

479. Chronic inflammation may originate in the acute or subacute forms, the vascular obstruction and excitement persisting in the part, even after some of the results (§ 445, formerly called terminations) of inflammation have been produced. Its general character is asthenic; but there may be considerable determination of blood and local excitement. Its effect in disturbing the functions, both of the part which is its seat, and of other parts, is much less prominent than that of acute inflammation; but its duration causes a more serious and lasting alteration of structure. The matter effused by serous membranes in chronic inflammation is always either cacoplastic or aplastic; hence, dense and contractile adhesions, or patches of fibro-cellular or semicartilaginous matter, cirrhosis, gray miliary tubercle, curdy and yellow tuberculous matter, may be numbered among the common products of chronic inflammation. Mucous membranes discharge muco-purulent, or curdy matter, and the more complex membranes of this class become thickened and may ulcerate. Submucous textures become the seat of deposit, which, in becoming organized, often contracts, forming strictures in mucous passages. These strictures, by obstructing the passages, may lead to dilatations above them. In glands, and other complex textures, chronic inflammation causes consolidation and induration, which often afterwards contracts and effects the obliteration of the connected texture, as in the changes in the lungs, liver, and kidney, inaptly described under the name cirrhosis.[1] Sometimes the indurated parts, from the pressure on

[1] Mr. Gulliver describes the consolidation of chronic pneumonia as characterized by "dark exudation corpuscles," as pale exudation corpuscles are the chief objects in red or

their vessels, become softened (§ 463), as in softening of the brain, or undergo a process of irregular suppuration and ulceration, as in the excavation of the lungs after chronic inflammation. As we noticed of congestion (§ 311), so it may be added of chronic inflammation, that the hypertrophy or excessive deposit of nutritive material is irregular, more in some textures than in others, generally abounding most in the interstitial cellular or filamentous tissue, which, by its hypertrophy, presses on the vessels and other textures, and often causes their atrophy and partial obliteration. Chronic inflammation in the cartilages ends in caries and ossification; in the bones also, it causes caries or exostosis, just as in the skin and other compound textures it leans to induration as well as ulceration. The production of these apparently opposite results by the same process, inflammation, is not paradoxical, when we bear in mind the compound character of this process, and the variations arising from different proportions of its elements and products. Chronic inflammation exhibits these opposite results the more strikingly, because its effects are accumulated by its long duration; the hypertrophy arising from one of its elements (determination of blood) increases in the immediate neighborhood of atrophy and ulceration, the results of another of its elements (vascular obstruction).

480. *Congestive* inflammation is that in which the accumulation and retardation of the blood in the vessels of the affected part predominate over the determination of blood. Hence it is commonly asthenic in its character (§ 477), and generally originates from causes producing congestion in the first instance (§ 403), the reaction which converts this into inflammation being imperfect or partial. Its symptoms are less prominent than those of more active inflammation, and partake more of the character of those of congestion. Thus there may be little pain, heat, fever, and other signs of irritation or increased action; but the redness (where visible) is more marked and deeper than usual, and if the organ be very vascular (as the liver, lungs, and kidneys), the swelling may be considerable. Congestive inflammation is usually subacute or chronic, not tending to speedy results; but a kind of flux or dropsy may occur early, as from congestion (§ 375). So, too, the solid or nutritive effusion is generally cacoplastic, like that of congestion (§ 311); hence the consolidations or indurations arising from it are often of a dense indolent kind, tending to contract, or to degenerate still farther into aplastic matter (tubercle). The inflammation of the lung supervening on disease of the heart, on bronchitis, and asphyxia, is generally congestive; and so is inflammation of the liver from any cause.

481. *Phlegmonous* inflammation is exemplified in the phlegmon, furuncle, or boil of the integuments. Its chief character consists in its being abruptly circumscribed by an effusion of solid lymph, which brings the inflammation to a termination, either by suppuration, or by slow subsidence, as in the case of blind boils. A highly fibrinous condition

acute hepatization. It appears, however, that these corpuscles are not dark from color, but merely from opacity, as pus and tubercle are; and they bear a farther resemblance to this last product, in their irregularity in shape, size, and composition, being of various shapes and consisting of molecules, generally without a nucleus, and often without envelop.—*Notes to Dr. Boyd's "Vital Statistics," Edin. Med. and Surg. Journ.* July, 1843.

of the blood (§ 195) contributes to render inflammation phlegmonous; but this form of inflammation is that commonly exhibited by cellular and parenchymatous textures. The type of phlegmonous inflammation is usually sthenic (§ 477); and even where it advances to suppuration or sloughing, it defends the body against the noxious influence of the pus and dead matter. Hence the fever is more inflammatory (§ 442), and the local pain, irritation, and heat are considerable.

482. *Erythematic* or *erysipelatous* inflammation is contrasted with phlegmonous, in its tendency to spread, not being attended with the effusion of plastic lymph. In its severe forms, it is accompanied by much redness, pain, or smarting, heat, and swelling; the effusion is chiefly serous or sero-purulent, and often raises the cuticle in blisters. In its worst kinds, it terminates in diffused suppuration, sloughing, or gangrene. The fever is also of a lower type (§ 443) than in phlegmonous inflammation; being attended by great weakness, disorder of the secretions, foulness or dryness of the tongue, with delirium, and confusion or dulness of the senses; and in the worst cases, the fever is typhoid, with stupor, muttering delirium, dry brown tongue, sordes on the teeth and lips, slight convulsive startings of the limbs (subsultus tendinum), fetid or suppressed excretions, and sinking.

These adynamic or typhoid symptoms show the presence of something more than a form of inflammation, and that something must be considered to be a poison. It is probable that this poison sometimes originates in infection (§ 93); for persons in the same room, or who have had much communication with a patient with erysipelas, have been more frequently attacked than others; but it is also pretty certain that bad ventilation, and a crowded, uncleansed state of surgical patients, are capable at any time of rendering common inflammation erysipelatous; and this effect is much promoted by unknown epidemic conditions of the atmosphere (§ 89). The most probable hypothesis which we can form of this matter is that, under certain circumstances, the products of inflammation become (as we know they sometimes do, § 470) poisonous; and capable of acting (as many animal poisons do) as local irritants and general sedatives or derpiments; that they then modify the character of the inflammation, and depress the whole vital powers (as we have found pus and gangrenous matter do, §§ 471, 475); and that their effects, and the general and local reaction against them (§ 17), lead to the various degrees and forms which we find erysipelatous inflammation and its accompanying fever present. The same morbid matter, being transferred by any of the three modes of infection (§ 94) to other persons, may induce erysipelas in previously existing inflammation, or if strong enough, may develop it anew in the body. The fact that patients often *sicken* with fever (rigors, vomiting, headache, quick pulse, delirium, &c.), before the erysipelatous inflammation appears, is a sufficient proof that the poison acts on the constitution as well as on a part; and the fact that weakly persons, and those with previous structural disease (especially of the kidneys), chiefly suffer from the worst effects of erysipelas, shows the essentially depressing operation of the poison. In several cases of the worst forms of erysipelas, I have found pus-globules in considerable numbers in the blood of parts remote from the affected textures; which corresponds with the

observations of Mr. Gulliver (§ 462). This might suggest that pus is the poisonous matter; but although it is highly probable that these pus-globules do partake of the septic tendency formerly noticed as belonging to foul kinds of matter (§§ 462, 3), yet it is likely that the noxious matter occurs and spreads in a more subtle form, in solution or even in vapor, as shown by the pernicious properties of the liquor puris, and its fetid odor (§§ 470, 472).

Some asthenic inflammations of mucous and serous membranes and internal organs exhibit many of the constitutional effects of the worst forms of erysipelas; they sometimes prevail when it is epidemic, and may be traced to the same infection. This may be said especially of puerperal metritis and peritonitis, erysipelatous tonsillitis and laryngitis, and suppurative phlebitis.

483. *Pellicular*, or *diphtheritic* inflammation of mucous membranes has some affinity to the erysipelatous, being diffused and spreading, generally asthenic, and accompanied with a low kind of fever. It is attended with more soreness than pain, little swelling, and a deep redness, which is early obscured by the characteristic film of grayish or dirty white albuminous matter, which is exuded on the inflamed surface. Patches of this kind often occur on the tonsils in sore throat, and have been commonly mistaken for sloughs. In certain epidemics, often connected with scarlatina, a diphtheritic inflammation affects the whole throat, and sometimes extends to the trachea and air-tubes, the mouth, the gullet, and to more or less of the alimentary canal. The films of lymph thus effused are often fetid, apparently from incipient decomposition, which is promoted by their exposure to air and moisture in the throat and air-passages. As in the case of diffused suppuration and gangrene, this result of inflammation thus tending to putrefy is at once a sign of the low condition of the vital powers, and a cause of their farther depression.

The exudation of lymph instead of mere mucus or purulent mucus, as usual, I am disposed to refer to the inflammation affecting the submucous cellular tissue, and being at the same time diffused like erysipelatous inflammation. Deep-seated inflammation of a more sthenic character is circumscribed by the effusion causing a thickening of the membrane, as in laryngitis; but the matter effused by diphtheritis, although fibrinous, is thin enough to transude through the mucous membrane on the surface of which it concretes. The thinness of the mucous membrane of the air-passages in children facilitates the transudation in their deep-seated inflammations; hence, at an early age, all such inflammations may cause an effusion of fibrinous matter, as we find exemplified in croup. So, too, the extreme tenuity of the mucous lining of the smaller divisions of the air-tubes makes the exudation of fibrinous matter a common result in pneumonia and some kinds of capillary bronchitis. This is exemplified in the ramiform moulds of the bronchial tubes sometimes expectorated. Similar skin-like exudations are sometimes passed from the intestines after the irritation of calomel or other strong purgative, and in some cases without any such irritation. I have had several patients under my care, who from time to time pass from the bowels a quantity of shreds

like white kid leather, without any symptoms of active inflammation; congestion seems to be a chief cause in these cases (§ 308).

In the mouth and throat, various asthenic inflammations seem to be capable of causing a fibrinous exudation, as that from mercurial action, and that in the aphthous mouth and throat of adults, which occurs towards the fatal termination of various chronic diseases. Recent microscopic observations have proved that in some of such cases at least, the film consists chiefly of a confervoid vegetable. I ascertained this to be the case with regard to a remarkably white curdy coating on the fauces and gums of an aged female now (July 1847) under my care in the hospital; the matter was almost totally composed of the jointed tubes, and brilliant sporules and granules of the parasitic growth. The aphthæ of children are somewhat different, being vesicular elevations of the epithelium, with or without an albuminous film underneath.

484. *Hemorrhagic* inflammation is entitled to be considered as a distinct variety. In most inflammations, there are slight extravasations of blood; but sometimes there is so much coloring matter in the inflamed texture and in the products effused, that it may be difficult at first to say from the appearance whether the disease is a hemorrhage or an inflammation. These inflammations I have found to be asthenic; often the subjects were scorbutic, or affected with purpura; and, as I have stated with regard to the latter disease (§ 358), there has been distinct evidence of imperfect action of the liver and kidneys. Thus, I have several times met with hemorrhagic pleurisy and pericarditis in conjunction with cirrhosis of the liver, and Bright's disease of the kidney. An altered condition of the coloring matter (§ 186) is perhaps more concerned in causing this result than a deficiency of the fibrine, to which it is commonly ascribed; in fact, this is found more or less in excess as in other inflammations, but very probably it may be defective in its usual contractile property (§ 203).

485. *Scrofulous* inflammation is decidedly asthenic, and exhibits many deviations from the common form of inflammation. It may be well exemplified in the lymphatic glands, one of its most common seats, and within the reach of direct observation. These glands, in common inflammation, become very painful and hot, as well as swollen, and the inflammation tends soon either to resolution or to suppuration. In scrofulous inflammation, on the other hand, lymphatic glands swell to a great size; and often the deep redness extends to the surface, but with little pain or heat; and the swelling remains for a very long period without either resolution or suppuration, and little influenced by antiphlogistic remedies. Sometimes it seems to suppurate, so that the swelling becomes distinctly fluctuating, and very red, as if ready to open; but afterwards the skin becomes wrinkled, and the swelling subsides. When it does burst, or is opened, the pus is serous and curdy, or mixed with matter of a soft cheesy consistence (soft tuberculous matter); and the abscess thus opened leaves a deep ulcer with a narrow orifice (fistula), which is indisposed to heal. The microscopic characters of scrofulous matter are a paucity and irregular form of the pus-globules and a great predominance of granular matter, loose or coherent in clots, and oil-globules in considerable numbers. These characters at once explain both

the aplastic and the indolent properties of the matter; being destitute of the organizability of fibrine, and of the cell-developing and endosmotic attributes of pus (§ 461). In proportion as it gets older, as in *cold abscesses*, the pus-globules become collapsed, and the liquid partly absorbed, the matter acquires a cheesy or putty-like consistence, and in time undergoes a farther change into fatty matter and phosphate of lime. The kind of inflammation from which this has originated occurs in persons of what is called the *scrofulous diathesis*, or *constitution*.

The scrofulous diathesis is merely a term employed to designate a state of the body in which scrofulous inflammation and malnutrition are apt to occur. It has been generally stated that this diathesis has certain outward marks, by which its existence may be recognized, independently of the actual occurrence of disease. Thus, a relaxed state of the muscles, a soft transparent skin, a fair or pale complexion, with partial patches of a peculiar pink or purplish redness; a pearly whiteness of the eye and teeth; tumid upper lip; fair or reddish hair; large and weak joints, precocity of intellect, and some other signs, have been described as characteristic of the scrofulous diathesis. But such marks may occur without any manifestation of scrofulous disease; and still more frequently, scrofulous disease is induced in persons quite destitute of these characters.

More constant concomitants of the scrofulous disposition (although they sometimes occur without scrofula) are various signs of weak circulation and imperfect nutrition, such as cold extemities; weak, but easily accelerated pulse; small development of muscles; uncertain digestion, and irregular excretion; slow or defective healing of wounds. The circumstances which most favor the production of the scrofulous diathesis, are also causes of a weakening kind, especially when these are long continued, such as poor or insufficient nourishment, especially in childhood or youth; cold and damp situations, or defective clothing; long confiinement in close ill-ventilated habitations; long-continued illness, especially from eruptive or typhoid fevers; and prolonged and aggravated disorders of the digestive organs. Scrofula is also, in a marked degree, an hereditary affection (§ 36); and mere feebleness of constitution in parents, whether original or from disease, or from excesses, or from age, often develops a disposition to scrofula in children.

In persons of the diathesis now noticed, inflammation frequently runs a course, and leads to results different from those of inflammation in a healthy subject. Commonly, the inflammation is more asthenic (§ 477); often it is more subacute or chronic (§ 479) than usual; but in all cases, its solid products are not euplastic (§ 450), as in healthy persons; and may be either cacoplastic (§ 452) or aplastic (§ 453), according to the prevalence of the scrofulous constitution, the texture affected, and the quantity of the inflammatory product thrown out. Where the scrofulous diathesis is most developed—where the texture inflamed is an internal one, not freely discharging externally, and where the product of inflammation is most copious—there the deposit will be most aplastic, consisting of scrofulous pus or yellow tubercle, devoid of regular structure, and wholly insusceptible of organization; and being not fit for absorption, it operates as a foreign body, irritating, obstructing, and compress-

ing the adjoining parts, in various ways detrimental to their functions and structure. Thus arise tuberculous or scrofulous deposits and abscesses in lymphatic glands, in bones, cartilages, and in the connected cellular textures, tuberculous infiltrations in the lungs, and deposits in serous cavities. Where the scrofulous diathesis is less pronounced, and the inflammatory effusion less copious and more gradual, the result may be a cacoplastic product, susceptible of only a low organization; as gray, miliary, and tough yellow tubercle; cirrhosis, atheroma of arteries, fibro-cartilage, and other degraded living solids. These have been already noticed (§§ 453, 454), and will again come under consideration as products of altered nutrition. The aplastic tendency of inflammation in scrofulous subjects is sometimes manifest in other forms in different textures. Synovial membranes of joints are softened into a brownish pulp (*Brodie*); articular cartilages and the cornea ulcerate, from absorption predominating over nutrition (§ 466); the integuments of the face and other parts inflame in small cutaneous tumors or tubercles, which ulcerate, and, for want of plastic material, the ulcers are phagedenic, spreading and destroying the nose or adjacent parts, as lupus.

It seems, then, that the most constant peculiarity of scrofulous inflammation is, that it degrades or arrests nutrition by supplying a material in a condition little or not at all susceptible of organization. This leads us to inquire what is the condition of the blood in scrofula; and we are answered by the interesting fact ascertained by Andral and Gavarret, before mentioned (§ 454), that there is an excess of fibrine (§ 195), but a deficiency of red particles (§ 185). The fibrine is, however, defective in that finely fibrillated structure indicative of vitality; and this seems to favor the hypothesis that the red particles are concerned in preparing this plasma (§ 210); where they are deficient, it is ill prepared.

486. *Gouty* and *rheumatic* inflammations have already been noticed in relation to their specific cause, a morbid matter in the blood or in the textures (§§ 251, 254); and some of the peculiar characters of the inflammation were then adverted to (§ 385). It is highly probable that the peculiarities of many other inflammations, especially of the skin, such as urticaria, eczema, psoriasis, and erythema may be referred to a similar cause, a particular matter in the blood irritating the parts through which it circulates (§ 402).

487. The poisons of *gonorrhœa* and *syphilis* excite inflammations still more peculiar in their phenomena and course. *Gonorrhœal* inflammation chiefly affects the genito-urinary passages and the conjunctiva. It is generally acute, and results in the secretion of an opaque sulphur-colored pus, which is capable of propagating the disease. Sometimes it affects the testicle also with acute inflammation, and the joints with more chronic, constituting gonorrhœal rheumatism.

Syphilitic inflammation exhibits great varieties in site and effects. Locally, the syphilitic poison may excite on any thin-skinned surface a papula, or small tubercle, which ulcerating, forms a chancre. As the matter is absorbed from this, it causes inflammation with great pain and swelling of the neighboring lymphatic glands (bubo), which may sup-

purate. These are primary inflammations, and of an acute character. When absorbed into the system, it may excite secondary inflammations; sore throat, generally asthenic, and tending to ulcerate; and a great variety of inflammations of the skin, which vary greatly in their type as well as in their character, according to the vigor, &c., of the subject. They often leave a peculiar lurid or copper-colored stain in the under layer of the epidermis, which obviously arises from an extravasation of some coloring matter of the blood, and probably implies a change in it. The periosteum and bones are also often attacked with syphilitic inflammation; and painful nodes, exostoses, suppuration, and caries may result. The iris is sometimes attacked with acute inflammation and effusion of lymph, which may endanger sight if not reduced.

TREATMENT OF INFLAMMATION.

488. We have found inflammation to be an essentially complicated process, composed of several constant elements, to which are frequently added others, which farther increase the complexity of the disease. A proper knowledge of these elements, and of the means which best remove or counteract them, separately and in combination, will form the best guide to the rational treatment of inflammation, and will supply a safe clue through the confused and paradoxical assemblage of agents which experience has proved to be *antiphlogistic remedies.* As we have not time to discuss in full detail the elements and results of inflammation with regard to treatment, it will be useful to enumerate these elements and results, with references to the text, which more fully explains them, and then to represent in a tabular view the remedies that may be opposed to these elements and results respectively; various combinations of which remedies constitute the *antiphlogistic treatment.*

489. *Constituents of Inflammation.*

From operation or exciting cause.	Congestion (§§ 403, 407), or Nervous and vascular irritation (§§ 402, 408).
Local elements of inflammation, (essential.)	Determination of blood towards the affected part (§§ 409, 419). Obstruction of the vessels most affected (§§ 410, 419); by atonic enlargement of the capillaries (§ 414); by production and adhesion of white corpuscles in the vessels (§ 415). Distension of arteries and capillaries BEFORE the obstruction (§ 420), causing increased effusion (§ 423) of serum, lymph, pus, &c. (§ 427). Emptiness of veins BEYOND the obstruction (§ 427), causing increased absorption (§ 467), hence softening, &c. Impeded or arrested circulation AT the obstruction (§ 418), causing a reduction or abolition of vital properties (§ 273), hence the death of the part, and its removal by ulceration (§ 466) and suppuration (§ 427), or its decomposition by gangrene (§ 473). Increased circulation of blood AROUND the obstruction (§ 410), causing exaltation of vital properties (§§ 421, 333); hence spasm (§ 113), pain (§ 135), sympathetic irritations (§ 149), increased secretion (§ 159), &c.

Constitutional effects of inflammation, (not essential.)	Extension of the excitement to the heart and arteries (§ 440), causing inflammatory fever. Change in the whole blood, by increase of fibrine from the inflamed part (§ 438), and by diminution of the excretions in the inflammatory fever (§ 441). Exhaustion ensuing after the excessive excitement (§ 116), or the effusions of inflammation (§§ 459, 470). Depression, sometimes with partial irritation, from the presence of pus or gangrenous matter in the blood (§§ 470, 475); and retention of excrementitious matter (§ 443).

490. TABULAR VIEW OF THE CHIEF ELEMENTS OF INFLAMMATORY DISEASE, AND THEIR REMEDIES.

CONSTITUENTS OF INFLAMMATION.	ANTIPHLOGISTIC REMEDIES.	
1. Congestion	Astringents; stimulants; evacuants (§ 315, *et seq.*)	For incipient inflammation.
2. Irritation of nerves . . .	Narcotics; counter-irritants (§§ 137, 155)	
3. — of vessels . . .	Sedatives; derivatives; evacuants (§ 342, *et seq.*)	
4. Determination to the part . .	Cold and other sedatives; derivatives; evacuants	For local inflammation.
5. Obstruction in the part — by atonic enlargement .	Remedies for congestion (see above) .	
6. — by adhesion of corpuscles	Remedies not known; attenuants? (§ 217); sedatives? (§ 416) . .	
7. Distension of vessels . . .	Counter-pressure; bloodletting; derivation (§ 319)	
8. Effusions	Evacuants; derivatives; operations; sorbefacients?	
9. Increased absorption . . .	Direct remedies not known; stimulants; diminishing atmospheric pressure on the part	
10. Impeded circulation in the part .	Moist heat and other stimulants .	
11. Increased circulation around .	Remedies for determination (see above)	
12. Excitement of the heart . .	General bloodletting and other evacuants; sedatives (§ 115) . .	For inflammation with fever.
13. — of the arteries generally	General bloodletting and other evacuants; relaxants (antimony, &c., § 122); salines?	
14. Change of the blood — by increase of fibrine . .	Bloodletting and other evacuants (§ 214); mercury; low diet . .	
15. — by diminution of the excretions	Evacuants; alteratives (§ 172, *et seq*)	
16. Exhaustion	Stimulants and tonics (§§ 119, 124) .	For results of inflammation.
17. Depression from poison . .	Stimulants; antiseptics; evacuants (§ 260)	
18. Effused products of inflammation	Evacuants; attenuants; alteratives; sorbefacients? stimulants; pressure, and friction	

491. My limits will not enable me to do more than offer brief comments on these principles of the treatment, and to exemplify the above table by the results of experience; and it is an important corroboration of the truth of these principles that they expressly indicate the advantages of the various remedies which have been found effectual in the treatment of inflammation, they suggest the peculiar uses of them respectively, and they open us a path of inquiry in pursuit of others which are yet wanting.

Remedies for incipient Inflammation.

1. *Congestion.*—The efficacy of topical astringents and stimulants in the congestion preceding inflammation, is illustrated in the effect of a strong solution of nitrate of silver or sulphate of zinc in curing conjunctival ophthalmia, and of the same agents, or powdered alum (Velpeau), or capsicum gargles, in curing an incipient sore throat. But as with regard to congestion (§ 317), so still more in the congestive stage of inflammation, if it be extensive, long established, or already complicated with determination of blood, they can never restore the lost tone, nor clear the obstruction of the vessels; and if not, they can operate only as irritants, and aggravate the inflammation; and it is especially under these circumstances that evacuants, derivatives, and even bloodletting are more appropriate. The utility of these has been mentioned under the head of congestion (§ 318); but they may be more necessary in the congestive stage of inflammation, inasmuch as it tends to farther and worse results. A strong purgative and diaphoretic, if given early enough, may suffice to remove an incipient inflammation; but if this inflammation be extensive, especially when the subject is plethoric, the proper remedy, even at this stage, is bloodletting, local or general, according to the situation and extent of the inflammation.

492.—2 and 3. *Irritation of Nerves and Vessels.*—The irritation of the nerves, which we have found to constitute a part of the commencement of some inflammations (§ 403), is so closely followed by irritation of the vessels, that their remedies are much the same. The efficacy of a large dose of opium in incipient inflammation exemplifies the utility of narcotics in subduing nervous irritation, and these remedies are the more indicated where pain, spasm, and other signs of excited nervous function (§ 151) predominate. On the other hand, where heat and redness rather prevail, the disturbance is more in the vessels, and the more appropriate remedies are sedatives, such as cold and saturnine lotions to the part, and various evacuants and derivatives, which draw the blood away from the distended vessels. Counter-irritants or revulsives of the most speedy operation, such as heat, dry and moist mustard poultices, and other stimulating applications, near the affected part, seem to act both on the nerves and vessels, and are powerful means of subduing the irritation which leads to inflammation. In these applications, the effect on nervous irritation is proportioned to the sensation which they produce, and where pain or other sign of nervous excitement predominates, a heat almost scalding or burning, or stimulating agents which cause severe smarting, are most effectual. On the other hand, where the vessels are excited, as evinced by heat and redness (if visible), counter-irritants or revulsives which act extensively rather than intensely are of more avail; such as a general or partial hot-bath, or large poultice, or fomentation, made more stimulant by various additions.[1] On the same principle,

[1] A great improvement in the means of fomenting parts with heat and moisture, with or without stimulating additions, is supplied in various water-proof fabrics, such as India-rubber cloth, oiled silk, or gutta-percha sheet, being applied as a cover, to prevent the escape of the heat and moisture. I have for many years adopted these auxiliaries with

purgatives and other evacuants continue to be indicated. Emollient and demulcent remedies, where they can be directly applied, often soothe an inflamed surface, both by promoting the natural secretion, by removing irritating matter which may have caused the inflammation, and by reducing the acrimony of the morbid discharge, which is often acrid (§ 455).

Remedies for established local Inflammation.

493.—4. *Determination to the part.*—This, with the following element, *obstruction in the part*, is only the farther result of irritation of the vessels; but it is here named as a constituent of established inflammation. It is to be opposed by the same remedies as those just mentioned for vascular irritation, and formerly noticed as suitable for simple determination of blood (§ 342, *et seq.*), but as part of a disease which is more enduring and serious, the determination attending inflammation requires a fuller than usual application of these remedies. Of the sedatives applicable to this element, none is so effectual as cold, which we have found more than any other agent to promote the contraction of arteries (§ 120). It is thus that ice and cold lotions are very salutary in reducing active inflammation, where they can be properly applied, as in external inflammation; in some internal inflammations the cold may be said to reach the interior, as by a bladder of ice to the head in meningitis, and by swallowing slowly small pieces of ice in gastritis. Cold will do harm instead of good in inflammation, either when it does not reach the enlarged arteries through which the determination takes place (§ 326), or when it is not sustained long enough to prevent the effects of reaction (§ 79), by which the arteries again become enlarged and determination is renewed. For these reasons, external cold applications are injurious in most internal inflammations, and if not steadily regulated, they may prove so in other cases likewise.

Warmth and other derivants, applied to parts more or less remote from the vessels which are the channels of determination, are very serviceable aids in the treatment of this element; thus partial or general warm baths, hot poultices, &c., operate. Diaphoretics, which equalize the circulation without stimulating, such as antimony, are also beneficial, by relaxing the cutaneous vessels generally, and thus deriving to the whole surface. So we have found (§ 345) purgatives and diuretics to operate as derivatives as well as evacuants; and bloodletting was then stated to be the most effectual of all (§ 346). Change of posture, by elevating the part inflamed, should also be mentioned among the means which counteract determination of blood.

These different measures, which may suffice in simple determination, may be insufficient for that attending inflammation, chiefly because they cannot easily be sustained for a length of time. To produce a more permanent derivation or revulsion, as well as to act as counter-irritants, various agents are used to excite artificial inflammations, which counter-

great advantage, especially where a prolonged effect is desired. The new India-rubber epithems, called piline and spongio-piline, recently introduced into this country by a former pupil of mine, Mr. Markwick, answer the same purpose.

act inflammatory disease by deriving and irritating in another direction. To this class belong blisters, mustard poultices, applications of tartar emetic, croton-oil, strong ammonia, mineral acids, some essential oils, heat above 120° Fahrenheit, &c.; varying in the amouut of inflammation which they excite according to the manner and duration of their application. As these fulfil several indications in inflammation they will again come under our notice.

494.—5 and 6. *Obstruction in the part, by atonic enlargement of the capillaries, and by adhesion of the white corpuscles and accumulated impaction of the red.*—These are classed together, because they jointly continue to produce the partial obstruction which is characteristic of inflammation. The atonic enlargement of the capillaries may be thought to be included in the congestion before noticed; but it stands here as a part of established inflammation, and therein different from mere congestion (§ 287). The remedies to be opposed to it are, however, the same as those mentioned under that head; but here they generally occupy a subordinate place, unless they fulfil other indications. There are, however, a few cases in which the treatment for congestion, even by stimulants, proves effectual in curing inflammation. Catarrhal inflammations of mucous membranes are sometimes removed by a highly stimulant treatment with wine, spirits, or ammonia. It is probable that the circulation is so much accelerated as to excite the dilated vessels to contract, and the obstruction is thus swept away. This treatment generally causes sweating and a deposit in the urine; but these seem to be as much the effects as the causes of the improvement, for sweating by other means is not so effectual. But this mode of treatment is hazardous, for it acts by increasing the flow of blood, and if this fail to remove the obstruction, it will surely aggravate the inflammation.

But the most constant and important part of the obstruction of inflammation is due to the unusual formation and adhesion of the white corpuscles in the inflamed vessels, and the consequent accumulation of red particles entangled in them; and inasmuch as it is this especially that establishes inflammation, and is the cause of its most serious results, it would be most desirable to find some remedial influence to counteract it. Unfortunately, however, we are not acquainted with any direct means of preventing the formation and cohesion of these pale globules, or of dissolving them when formed. As these globules appear to be formed in the blood-liquor, we should look for the desired remedies among the medicines which affect the blood; and it might be surmised that alkaline and other salts may possess this virtue. The efficacy of carbonate of potash as an antiphlogistic remedy has been much vaunted by Sarconi and other Italian writers; but this is not confirmed by general experience. In fact, it appears from the experiments of Mr. Blake (§ 214), that salts of potass, injected into the veins, promote the coagulation and stagnation of the blood instead of preventing them. Again, if the chemical view of their formation which we have proposed be correct (§ 417), it may be inferred that such means would be most effectual as would interrupt the hyperoxidation of the plasma; and as this depends on the determination of arterial blood to the part, we are led to see a new and important advantage accruing from the operation

of depletion, derivation, sedatives, and other means calculated to reduce the force of the local and general circulation, and the richness of the blood which supplies the inflammatory material. Whether any deoxidizing agent could be made to assist towards the same end is a question worthy of investigation; most materials of this description are objectionable on account of their stimulant or heating influence, as, for example, alcohol and oils; and in a minor degree, sugar and starch. The deoxidizing agent should possess no such property, either before or after its own oxidation. Has the antiphlogistic operation of antimony and mercury any relation to this mode of action? Their virtue is chiefly confined to their protoxides and proto-salts. Analogous preparations of other oxidizable metals, which have no stimulant or injurious action, and sulphurets of metals and alkalies, have formerly enjoyed some repute as remedies in inflammation, and may deserve farther trials. The most efficacious remedy that I know for certain cutaneous inflammations, such as acne simplex in an excited state, is a weak solution of sulphuret of potash used as an outward application; and sulphuretted waters are acknowledged to be useful soothing agents in irritable states of the alimentary canal—both possibly owing to an operation of this kind.

495.—7. *Distension of Vessels.*—This is another of the more characteristic constituents of inflammation, and has been explained to be the result of determination of blood into congested and obstructed vessels. In congestion, we formerly found distension sometimes to occur (§ 306); but there it is chiefly in the veins; here it is in the small arteries, and all those parts of the capillaries that are on the arterial side of the obstruction. This may account for the greater degree of distension, and the larger amount of effusion and other changes that result from it. But the peculiarity of the inflammatory distension and of the effusions which result from it, cannot be well understood, without keeping in view that concentration or exaggeration of influence exerted by the red particles on the liquor sanguinis, when, on their accumulated and impacted masses, a strong current of arterial blood is continually impelled (§ 416). This view, too, suggests that the most effectual means of relieving it will be by speedily lessening either the determination of blood or the obstruction. The measures for reducing the determination must be now of the strongest kind, such as bloodletting and free derivation or evacuation; because the arteries which are the seat of determination are closed at most of their capillary ends, and must be drawn upon either directly or through means which reduce the pressure in the arteries generally. Where, therefore, there is any considerable determination of blood, the distension which it causes will not be relieved without drawing blood either from the enlarged vessels themselves, or from other parts, in sufficient quantity to reduce the heart's action and the general arterial pressure.

Other slighter means give some relief to the distension of the vessels in inflammation. External pressure, carefully equalized, can sometimes do this, as in the effect of well-applied bandages and strapping on wounds. Fluid pressure, as proposed by Dr. Arnott, by means of quicksilver, or the slack air-cushion under a bandage, might be still more useful in various external inflammations, because its equality insures its proper application. It is very probable that a part of the efficacy of

poultices depends on the soft and uniform pressure which they produce on the inflamed vessels. But certainly poultices, fomentations, and other means of applying moist heat, relieve distension in part also by relaxing the solid fibres, and by promoting the exudation of the watery parts of the blood.

496.—8. *The effusions from the vessels* are the result of their continued impulsive distension. They may, therefore, be prevented or lessened by means which reduce this distension; but in severe cases of inflammation, effusion is the natural mode in which the vessels are relieved of their load; and we have just mentioned that poultices and fomentations give relief by promoting this result. If the effusion is outwards, as from a mucous membrane, it may not be necessary to check it, except so far as it may interfere with the functions of the part; but if it be too thick, alkaline medicines sometimes succeed in attenuating it, and thus promote its discharge; whilst acids and various astringent remedies check it when it is too profuse; but blisters and various evacuants should be combined with these last, otherwise the inflammation may be increased. This corresponds with what has been said of the treatment of sthenic fluxes (§ 393). When the effusion is in cellular texture, a serous cavity, or parenchyma, it may more seriously interfere with the functions of the part; and it may be more important to prevent, or restrain, or remove the effusion. Thus, in the submucous cellular texture of the glottis, or in the serous membranes of the brain, a little effusion may prove fatal; and in the lungs or pleura, effusions are injurious in proportion to their extent. Besides the measures directed against determination and vascular distension, it is doubtful that we possess means of restraining effusion. It is pretty certain that some other antiphlogistic remedies, especially mercury and antimony, do diminish the effusions of inflammation, and promote their reabsorption; but it is not clear that they do so in any more direct way than by reducing the local and general excitement, or by their evacuant effect. The expressions, "sorbefacient," and "exciting the absorbents," hypothetically ascribe to remedies the property of increasing absorption; but nothing in physiology points out any direct mode in which absorption can be artificially increased. A free action of the excreting organs promotes absorption, by reducing the distension of the vascular system. Absorption is also promoted by a circulation that is free, without excitement or distension;[1] and the return of the vessels to a healthy state is generally attended with more or less absorption of the effusions. It is probable that blisters and other counter-irritant applications near the inflamed part promote absorption, not merely as evacuants or derivants, but also by causing a rapid flow of blood through the adjoin-

[1] In my Gulstonian Lectures (*Med. Gaz.* July, 1841), I adverted to the effect of a rapid current in promoting absorption. Mr. G. Robinson has since illustrated this effect by some experiments (*Med. Gaz.* May, 1843). Another influence which probably contributes, is the different density of the fluid within and without the vessels: that within is more dense and saline, and, by the law of endosmosis, tends to attract the thinner fluid from without. This explains the greater readiness with which the thinner effusions are absorbed. Can we increase absorption by rendering the blood more saline than usual? The thirst after taking salt food would seem referable to this cause; and the beneficial influence of salines in inflammatory diseases may be partly due to this mode of operation.

ing vessels, which facilitates the endosmosis and removal of effused fluids. Hot fomentations and douches and stimulant frictions seem to operate in the same way.

In various cases, it is necessary to give vent to the accumulated effusion by surgical operation, as by incisions or acupunctures in erysipelas, opening abscesses, paracentesis in empyema, &c. This is chiefly necessary where the effused matter is purulent and little susceptible of absorption, as well as noxious to the system; but sometimes the mere quantity or situation of the effusion, by endangering life, renders the resource of an operation necessary, as in acute laryngitis and some cases of pleurisy.

497.—9. *Increased absorption* is manifest in the processes of softening, ulceration, and suppuration. I have endeavored to explain how, in the midst of distended and effusing vessels, absorption is increased. The veins and lymphatics are free, and, by the motion communicated to them from the current of the neighboring and anastomosing branches, they are ready to convey away all the fluids that can pass through their coats. (*Gulstonian Lectures*, 1841.) In fact, this is doubtless a provision for the removal of superfluous matter, old and new; but the process becomes injurious and destructive when it predominates over effusion, and extensively invades the living textures. But we have found reason to suppose that textures do not fall a prey to the softening or ulcerative process, unless their vitality is lowered and their nutrition impaired by a defective supply or quantity of blood (§§ 466, 7); and that inflammation does produce these effects very differently in different cases. Sometimes local stimulants and general tonics check softening and ulceration by improving the vitality and nourishment of the obstructed part; but they may have the opposite effect if the circulation in the affected part is too much obstructed to admit of increase. Hence we find, in phagedenic ulcerations, stimulants sometimes check and sometimes aggravate the disease. The increased absorption which forms a part of ulceration might be arrested by diminishing atmospheric pressure on the part, as by applying a cupping-glass over a phagedenic ulcer; but such an expedient is rarely practicable.

498.—10. *Impeded circulation in the part* has been just adverted to as contributing, with increased absorption, to the processes of softening and ulceration; but its greatest effect is manifest in gangrene, or the complete death of the part. In suppuration, also, the part dies, but it is removed by absorption, and replaced by pus, which makes its way to the exterior. Of the few agents that may be directed to restore or improve obstructed circulation, heat is the chief one to be named. Heat enlarges vessels, especially arteries (§ 120), and facilitates the passage of blood through them; and although, for this very reason, hurtful in sthenic inflammation and in parts where determination prevails, it is really very beneficial in the stages and forms of inflammation in which obstruction predominates and endangers the vitality of the part. Hence the utility of hot fomentations or poultices in low forms, or advanced stages of external inflammation. In slight cases, frequent applications of heat and moisture may entirely remove the obstruction, restore the circulation, and thus the life of the part, although the inflammation may have already caused much effusion. In other cases,

heat does not remove the obstruction, and therefore does not maintain the life of the part; but by increasing the determination around it, it promotes its removal by suppuration, and it hastens and matures this process, which is the best by which a part, the circulation of which is obstructed, can be removed. In a similar way, too, heat favors the effusion of lymph, which circumscribes the suppuration and prevents it from spreading or infecting the system. Lastly, in a similar way, heat and other stimulating applications promote the process of separation or sloughing of a gangrenous part (§ 475), the whole circulation and life of which have ceased. These latter effects of heat may often be promoted by medicines and food calculated to maintain the vigor of the general circulation.

499.—11. *The increased circulation around the obstructed part* is often that constituent of inflammation which causes the most prominent symptoms, the greatest heat, pain, tenderness, and other marks of excited function being commonly dependent on it. We have already noticed determination as an element of inflammation in its early stage, and refer to that clause (4) for an account of the remedies with which it is to be combated. We now advert to determination to the neighboring vessels as a part of the extending irritation of inflammation, which often sympathetically excites the whole system into fever. The treatment, therefore, partakes of the character of that suited for inflammation with fever.

Treatment of Inflammation with Fever.

500. The fever excited by inflammation consists chiefly of the items mentioned in the table; but it will be more convenient to notice them here together. They are—(12) *Excitement of the heart and* (13) *of the arteries;* (14) *change in the blood by increase of fibrine, and* (15) *by diminution of the excretions.*

The addition of fever to inflammation very materially modifies the treatment. The disease then to be treated is not merely the inflamed part, and a few other parts in sympathetic relation with it, but the whole vascular system, its blood, and the secretions and functions which it supports. In like manner, the treatment must now become general instead of local; not because the local inflammation has lost its importance, but because it has now become a part of a general disease, which sustains it with such an energy that local remedies become trivial, or even injurious. Thus, when inflammation is backed by febrile excitement of the heart and arteries, the stimulant and astringent antiphlogistic remedies (§ 491) irritate the distended vessels instead of making them contract. What can local bloodletting do, when there is an excited force from behind impelling the blood to the inflamed part more rapidly than the oozing by local bleeding can relieve it? Derivants also have little power when the tension of the whole vascular system is so much raised. Counter-irritants must even prove injurious, by adding another cause of excitement to the system. So, too, narcotics can have no control over fever once established, and may prove hurtful by exciting the nervous centres, and still farther impairing the secretions (§ 166). Under these

circumstances, a more general remedy is wanted, which shall reduce the action of the heart and arteries, and diminish the inflammatory character of the blood. The first and most powerful remedy of this kind is general bloodletting; next come the stronger evacuants, antimony and mercury; and lowest in power are what are called refrigerants and direct sedatives. We shall briefly notice these antiphlogistic remedies.

501. Bloodletting, if carried far enough, is sure to reduce the action of the heart; for, as formerly explained, it may produce syncope (§ 70). A remarkable fact, first pointed out by Dr. Marshall Hall, is, that, in inflammatory disease, a much larger amount of blood may be drawn without producing syncope, than can be taken in health or in other diseases. The following is Dr. M. Hall's table of the results of his investigation of the tolerance of bloodletting in different diseases. The numbers represent the mean quantity of blood which flows before incipient syncope in the sitting or erect posture:—

I. AUGMENTED TOLERANCE:—	
Congestion of the brain	℥xl—l.
Inflammation of serous membranes Inflammation of synovial membranes Inflammation of fibrous membranes	℥xxx—xl.
Inflammation of the parenchyma of organs (brain, lung, liver, mammæ, &c.)	℥xxx.
Inflammation of skin and mucous membranes (erysipelas, bronchitis, dysentery)	℥xvi.
II. HEALTHY TOLERANCE:—	
This depends on the age, sex, strength, &c., and on the degree of thickness of the parietes of the heart; and is about	℥xv.
III. DIMINISHED TOLERANCE:—	
Fevers and eruptive fevers	℥xi—xiv.
Delirium tremens and puerperal delirium	℥x—xii.
Laceration or concussion of the brain Accidents before the establishment of inflammation Intestinal irritation	℥viii—x.
Dyspepsia, chlorosis	℥viii.
Cholera	℥vj.

The explanation of the increased tolerance of bloodletting in inflammation is, I apprehend, to be found in the increased excitability of the heart, and tonicity of the arteries, which maintain a sufficient force and tension to preserve the circulation, especially through the brain (§ 266), even when much blood is lost. In asthenic or atonic diseases, on the other hand, the arteries being lax, and ill-fitted to transmit the blood, a smaller loss is felt, and syncope may result. The variations between inflammations occupying different seats, must be referred to the heart's strength, and the arterial tone being less augmented in some than in others; and are, therefore, indications of more or less sthenic (§ 477) character of the inflammation. The quantity of blood in the whole system will affect the heart's action and arterial tension in a similar way; and no doubt the more stimulating quality of the blood may contribute to the same results.

502. The object of bloodletting in inflammation is not merely to produce syncope, or a temporary impression on the pulse, but a perma-

nent reduction of the excitement of the heart and arteries; and this is to be effected in different modes of bloodletting under different circumstances. Where the inflammation is quite recent, and the fever has not existed long, a moderate amount of blood, rapidly taken from a large orifice, or from two arms at once, or even from the jugular vein, will often be sufficient to reduce the fever and inflammation. The circulation is thus reduced, perhaps, to syncope; and, relieved of the pressure and determination of blood, the inflamed vessels soon recover their normal state, if not spontaneously, at least with the aid of some of the subsidiary antiphlogistic measures. The benefit resulting from this mode of bloodletting in recent cases is sometimes very striking, and the cure is effected at a comparatively small expense of blood.

503. But the case is different when an acute inflammation and fever have lasted for two or three days. There is then not merely excitement, but sundry changes in the inflamed part and in the blood, which keep up the excitement; the inflammation has become established in the part, and the fever in the system; and no brief impression on the circulation, however sudden and complete, can remove them. If in this state a patient be speedily bled to fainting, reaction will soon come on, and renew the fever with increased intensity. Here, therefore, it is necessary to bleed more slowly and to draw more blood; and instead of promoting the occurrence of syncope by the erect or sitting posture, it is proper to keep the patient in an easy recumbent or reclining position, and to watch for the good effect of the bleeding in the softening of the pulse, or the relief of the pain, or other distressing symptom. The actual occurrence of syncope is rather to be avoided, and may be prevented by untying the arm as soon as the lips lose their color, or the patient complains of feeling sick or faint. Thus practised, bloodletting causes a more permanent reduction of the active elements of inflammation and fever, diminishes the exciting and too fibrinous condition of the blood, and, although it cannot repair the changes already produced in the inflamed part, it prevents their increase, and puts them in a condition favorable for the curative efforts of nature and the farther operation of other antiphlogistic remedies. In the more severe and confirmed cases of inflammation it is often requisite to repeat the bloodletting again and again; the indication for this being the return of incompressibility of the pulse, heat of skin, and a new aggravation of the symptoms. In all such cases, the advantage of the gradual over the sudden mode of bloodletting is apparent; for where the reducing influence of this measure is longest sustained, it is least necessary to resort to it again.

Another case in which it is expedient to draw blood largely rather than suddenly, is where inflammation is combined with plethora. On the other hand, in anæmic subjects, the blood should be economized as much as possible; the early depression from the loss of blood should be promoted by a posture favoring the occurrence of syncope, and might be sustained by the influence of antimony and other remedies. In some such cases, the temporary withdrawing of a portion of blood from the heart and large vessels, by means of the process of *hæmostasis*, may be very beneficial; by ligatures passed around one or more of the large

limbs, more or less blood may be arrested in the limbs, and for the time withdrawn from the current of the circulation (§ 318); this expedient is preferable to dry cupping, because it does not equally spoil the blood thus arrested.

504. After the general excitement has been lowered or removed by general bloodletting, the local inflammation often has to be treated by topical bloodletting, which now is not only more efficacious in reducing the determination and distension of the inflamed part, but contributes to keep down the general excitement. In fact, local bloodletting, as by cupping or numerous leeches, may be made so extensive as to be tantamount to general bloodletting; and the cases in which it has most of this effect are those in which slow bleeding answers best. In either extreme of age, and in the feeble, local bleeding only is admissible. Local bloodletting is chiefly suitable for inflammations which are superficial and extended, as those of the pleura or peritoneum. It is of much less avail in pneumonia, cerebritis, and other inflammations of deep-seated or parenchymatous organs.

505. Of other evacuants none are equal to purgatives, which are a great aid to bloodletting, and should be used in most cases of severe inflammation, uncomplicated with gastro-enteritic irritation. They operate on so large a surface that they affect the system, and their effect may be pushed to the extent of producing syncope; but such an extreme result is attended with much exhaustion, and their continued use may cause intestinal inflammation. The chief benefit arising from purgatives may be obtained from a few efficient doses at the commencement of the treatment. These aid the depressing effect of bloodletting, remove feculent matter, which is often a source of irritation, and clear the intestinal canal for the operation of other medicines. The stronger and less heating purgatives are to be preferred, such as calomel, jalap, salts and senna, combined with tartar-emetic or colchicum. A combination of several, which operate most on different parts of the canal, answers best.

506. Of internal remedies against inflammation with fever, that which most resembles bloodletting in its effects, is tartarized antimony. It is far less sure in its operation, and its influence is not proportioned to the quantity; yet under its use, especially if preceded by bloodletting, the pulse becomes less hard and frequent, the heat of skin is moderated, and sometimes perspiration ensues, whilst the local symptoms are generally more or less improved. Sometimes it causes vomiting, more rarely purging; but its best antiphlogistic operation occurs where these effects do not ensue to interfere with a continuance of the medicine; and I have frequently found its utility most marked, when it did not cause even nausea or profuse diaphoresis. Tartarized antimony, and the milder preparation, James's powder, have been very long used, in this country, as febrifuge medicines; and Dr Marryatt, who practised at Bristol in the last century, prescribed the former in large doses in the treatment of inflammation. The practice was since carried to a greater extent by Rasori, and other Italian physicians, who gave from 10 to 120 grains in twenty-four hours. Laennec adopted the use of the remedy in more moderate quantities, giving from one to four grains, in some agree-

able vehicle, every second or third hour for six doses; then intermitting or continuing it according to circumstances. In pneumonia and rheumatism, he considered it the chief remedy. Most practitioners in this country now consider tartar-emetic a valuable aid in subduing inflammation, chiefly to be used after bloodletting; or in slighter inflammations, where bloodletting is inexpedient. I rarely find it useful to raise the dose beyond two grains every three hours; and in most cases one grain, half a grain, or even less, will suffice. The first doses sometimes cause vomiting; but this generally subsides when the doses are repeated, and may be prevented by giving the medicine in a mild neutral saline draught, with from five to ten minims of the diluted hydrocyanic acid in it. Antimony acts most satisfactorily in inflammations of vascular parenchymata and complex membranes; such as the lungs, the testicles, the mammæ, the air-passages, the cellular membrane and skin, and the joints. It is less effectual in inflammations of serous membranes, and would be unsafe in inflammatory affections of the intestinal canal. It is most beneficial in the early stages of inflammation, especially when attended with fever; and seems to have little effect on the products of inflammation.

How antimony operates in reducing fever and inflammation is quite uncertain. Rasori considered it to be a direct sedative or *contro-stimulant*, diminishing the excitability of the vascular system, and thus neutralizing the inflammation. He supposed that the *tolerance* or power of the body to bear large doses of the remedy, entirely depends on the presence of inflammation in the system; but, as Laennec has observed, this is not correct; for although patients suffering from inflammation are less easily nauseated than others, yet after the inflammation has been subdued, those quite convalescent have continued to take 12 or 18 grains daily without nausea, or loss of appetite. Laennec first considered that the medicines act as a revulsive, by irritating the stomach; but this view being made by the Broussaians a ground of opposition to the use of the remedy, Laennec latterly represented it to act as a sorbefacient. It seems to me that the most reasonable view to take of its operation is, that it chiefly acts by diminishing the tonicity of the vascular system (§ 122). Small doses certainly relax the pulse and skin, and, where there is no fever, produce perspiration without stimulating. They also seem to increase the biliary and intestinal secretion. In inflammation and fever, larger doses are required to produce the same result; and as soon as the excessive arterial tension is relaxed, the chief part of the fever is removed (§ 441). By thus reducing the increased tonicity of the arteries, the circulation is equalized and quieted, and the determination to and distension of the inflamed part are diminished; and the vessels generally are placed in the condition for their natural offices of secretion, which their extreme tension had before interrupted. It is quite possible that this operation of antimony, and another more directly exercised on the inflamed vessels, may be dependent on a chemical deoxidating influence attaching to the protoxide of the metal, as before hinted at (§ 494), and this notion would account for the greater tolerance of the medicine under inflammatory disease, which involves a process of hyperoxidation. These views are, however, at present, no more than

hypothetical, and might with advantage be tested by experiments on the lower animals.

507. Another great remedy in inflammation is mercury, alone or combined with opium. The combination of calomel and opium was first employed by Dr. Hamilton of Lynn Regis; and the rules which he proposed for its use have hardly been improved on. After a sufficient venesection and a full purge, he gave from one to five grains of calomel with from one-fourth to one grain of opium every six, eight, or twelve hours. When much fever was present, with dryness of skin, he added tartar-emetic and camphor. If no relief ensued in twenty-four hours, venesection was repeated. Most practitioners admit the power of this remedy, although some ascribe its efficacy to the mercury, others to the opium; and the proportions of each have been variously altered. The beneficial effects of this remedy generally, but not entirely, depend on the mercury affecting the system, as manifested in adults by the fetor of the breath, and the tenderness and swelling of the gums; and in children, by spinach-like evacuations from the bowels. Improvement is, however, often manifest before these results take place. In iritis, the influence of mercury is quite visible in removing effused lymph; and it thus obviously in some way promotes absorption, as well as prevents effusion. The same "sorbefacient" operation is seen in the effect of mercury in removing the callous margin of indolent syphilitic ulcers, and in promoting the spread of phagedenic ulcers. Dr. Farre thinks that mercury destroys the red particles of the blood, and causes in the system a disposition to erythematic inflammation, which is incompatible with phlegmonous or plastic; but this is opposed by the fact that lymph is thrown out, and granulations form, and healthy ulcers heal during mercurial action. It will be useful to give briefly a view of the operation of mercury and opium; for although we cannot be confident as to its entire accuracy, yet it is founded on what is best known of the effects of these medicines, and may therefore be a guide in their administration.

The opium is useful in preventing the calomel from purging, and especially in subduing the nervous irritation attending inflammation, and which we have found to be one cause of that sympathetic excitement which, when complete, constitutes fever (§ 440). This salutary effect of opium alone is sometimes seen when the vascular excitement has been subdued by a large bloodletting, and in cases in which nervous irritation forms a chief element of the disease; here, a full dose of opium will subdue the remains of the inflammation better than any other antiphlogistic remedy; it seems to paralyze those sympathies which are concerned in renewing or maintaining the excitement of inflammatory fever. So, too, in combination with mercury, the opium exercises this narcotic influence; whilst the mercury prevents its astringent effect on the secreting organs (§§ 66, 173). The mercury acts farther; it augments the biliary and intestinal secretions; sometimes inducing copious mucous and bilious evacuations; and from its effect in iritis, it may be presumed to facilitate the solution and removal of effused lymph. How it has this effect is quite uncertain; probably it is by changing the condition of the blood, by a diminution of the fibrine and white corpuscles, the increase

of which is much concerned in contributing to the changes of inflammation. So we find mercury chiefly useful where the blood is very much buffed, and there is tendency to copious fibrinous effusions as in inflammations of serous membranes and croup. Calomel and opium have little influence over high inflammatory fever; and the system thus excited generally resists the mercurial action. This remedy has no farther sedative effects than those which proceed from its action on the intestinal canal; and, unless to produce this action, it is not well adapted for the earliest stage and most active forms of inflammation. In these circumstances, bloodletting is more required with mercury than with antimony; and if fever returns during the action of mercury, bloodletting or active purging may be necessary to reduce it. In fact, the operation of calomel and opium is less antiphlogistic, and more alterative, than that of bloodletting or antimony; it is inferior to them in the power of reducing inflammatory fever and active inflammation, but it is superior to them in arresting and removing the more plastic products of inflammation. Besides this comparatively slow influence produced by mercurial preparations generally there are others more peculiar to calomel, which render it a most useful remedy even in active inflammations; when given in large doses (from grs. v. to ℈j) it acts as a powerful cholagogue, and often causes the evacuation of dark-green matter, which, according to the examination of Dr. G. Bird, resembles the coloring matter of the blood rather than bile, in composition. This operation of calomel does in truth resemble that of bloodletting, being more actively antiphlogistic than that of small doses. This mode of exhibition has been much used in India, and in this country has been employed with much success by Dr. Chambers. The chief evil attaching to it, is its tendency to induce inflammation of the large intestines and dysenteric straining; and for this reason it cannot be long persisted in.

508. As considerable aids in the treatment of inflammatory fever, although quite inefficient alone, must be mentioned various saline medicines, such as nitrate of potass, and the alkalies combined with vegetable acids. Diluted solutions of these allay thirst, and seem to cool the fever; hence they have obtained the title of refrigerants. It is uncertain how far they may operate in diminishing the cohesion of the corpuscles and excess of fibrine in the blood (§ 438); but we can distinctly trace their good effect in augmenting the secretions, particularly that of the kidneys (§ 256). They are all more or less diuretic; and most of them also supply an alkaline base, which, by uniting to the lithic and lactic acids formed in the blood, facilitate the separation of these matters by the kidneys. Colchicum and digitalis are sometimes reckoned among antiphlogistic remedies; but in common inflammation, they are of very inferior power. In the absence of high fever, colchicum somewhat resembles mercury in its special action on the secretion of the liver, and it augments the elimination by the kidneys (§ 257); and digitalis acts as a diuretic, as well as a sedative on the irritability of the heart; but during severe inflammation, these effects are scarcely produced by doses which it would be prudent to administer. The same remark is applicable to hydrocyanic acid, and various preparations of aconite. There can be no question that both of these are capable of depressing the action of the heart, and thereby of reducing the force of the circulation; but,

in order to have such an effect during the excitement of active inflammation, it would require large and dangerous doses.

509. The utility of counter-irritants as a remedy for several elements of local inflammation has been already noticed (§§ 493, 496); but their operation is positively injurious in sthenic inflammation during the prevalence of fever. They then add to the excitement of the system; and in proportion to the inflammation which they excite, they prove a new source of the inflammatory changes in the blood (§ 438). But after the fever has subsided under the influence of remedies, or is exhausted by time, the advantage of counter-irritants predominates. The seat of their application, too, ought to have regard to the excitability of the vascular system; where this is great, the counter-irritation should be more remote from the seat of inflammation; where the excitability of the vessels is much reduced, blisters may be applied in close vicinity to the affected part. Blisters and suppurating counter-irritants, which cause copious discharge, are the most useful; tending to draw away the remains of inflammation, and to promote the removal of effused matters left by it. These become chief remedies as inflammation inclines to a chronic state, or where it has left such structural changes as cannot be speedily removed.

510. The *antiphlogistic regimen* comprises the avoidance of all circumstances and agencies capable of exciting or fatiguing the body or mind of the patient. Absolute rest in bed, in a very quiet, rather dark, yet cool and carefully ventilated apartment, is most favorable to the restoration of tranquillity to the circulation. The exclusion of noise, bustle, and other causes of excitement, and the careful removal of all irritating excrementitious matters must not be omitted.

The *antiphlogistic diet* comprehends the same negation of all irritating, stimulating, and the more nourishing articles of food. The proteinaceous materials, meat, eggs, and in severe cases, even bread and milk are to be prohibited, as well as all oily nutriment, which tend to increase the heat of the body; amylaceous, gummy, and saccharine matters may be taken sparingly, and are best exhibited in thin fluids, such as barley-water, tea, weak gruel, and arrowroot, and the like. The thirst generally present suggests the need of diluents, which are farther useful in cooling the body, and in promoting the action of diuretic, diaphoretic, and other evacuant medicines; but even these, if used to excess, tend to oppress the stomach and disturb the heart's action; and in cases of inflammation of the lungs and of mucous membranes, may prove hurtful by augmenting the bulk of the circulating fluid. When fever is present, the total loss of appetite is a sufficient guide to the necessary abstinence from food, and the stomach often will not retain or digest any but the weakest nutriment; but this is not the fact in all cases of inflammation where the restraint may be equally called for.

511. *Exhaustion. Depression from Poison.*—(See Table, 16 and 17.) The exhaustion ensuing after long-sustained excitement of inflammation and fever, often renders stimulants and tonics, as well as a generous diet, necessary in the after treatment; but the greatest circumspection is necessary, to be sure that these measures shall be proportioned to the

wants of the case, and not pushed so early or so far as to rekindle the inflammation afresh, or to produce other disorder in the weakened organization. No diffusible stimulant is more generally or safely applicable at this juncture than preparations of ammonia, which are conveniently exhibited by adding the carbonate of ammonia to the saline draught. It seems possible that its utility may partly depend on its supplying the azote necessary to convert amylaceous and saccharine nutriments into albuminous or gelatinous principles, according to a conjecture lately proposed by Dr. Alison. Alcohol and ether more obviously act by supplying a material for animal heat, which may also prevent the oxygen of the blood from preying too much on the materials of the textures. Similar aids are required, but are less successful, in supporting the system against the pernicious influence of purulent or gangrenous matter resulting from the inflammation. Even in cases of suppuration, the occurrence of the premonitory rigors, the diminished strength of pulse and heat of skin, point out the time for changing the reducing plan for one more supporting; but the degree to which the change is made must depend on the symptoms, and on the efficiency with which nature is attempting the process of limiting the destroyed part. When suppuration has commenced, there is no probability of its retrogression; and therefore the obvious indication is to promote its completion, and to prevent its extension and the diffusion of the pus through adjoining parts and through the system. This indication is best fulfilled by local stimulants, especially heat combined with moisture. This promotes determination of blood to the part, whereby the pus-globules are fully developed and the compressed fibrine and tissue dissolved and absorbed (§ 461), whilst surrounding vessels, inflamed but less obstructed, are throwing out a barrier of lymph, retaining its vitality and resisting the action and progress of the pus in all directions, except that in which the textures yield most, and through which it finds vent; this is promoted by various expedients described in surgical works. The local treatment of gangrene also requires more or less of the aid of stimulants to aid the process of separation or sloughing of the dead from the living parts. It is probable that, in all cases, some purulent or some gangrenous matter finds its way into the circulation; therefore, in addition to stimulants and tonics, antiseptics (such as chlorinated liquids, nitromuriatic acid, chlorate of potass and creosote), are sometimes with advantage given internally to counteract the septic influence; and above all, the secretions are to be kept free to promote the elimination of the morbid matter (§§ 260, 443), the foul nature of which is often evinced by the fetor and disordered appearance of the feces and urine. For a similar reason, foul suppurating and gangrenous sores are dressed frequently, and their discharge corrected and promoted by antiseptic and alterative applications.

18. *The Removal of the Products of Inflammation.*

512. The serum, liquor sanguinis, and the healthier kind of fibrine and exudation corpuscles (§ 424), are removed by the natural process of absorption (solution by conversion into tritoxide of proteine or other soluble products, and subsequent endosmosis into the adjoining vessels),

aided by various remedies before mentioned, particularly blisters and other counter-irritants, mercury, iodine, iodide of potassium, colchicum, and other diuretics. As a free circulation of blood probably promotes the removal of effused solids, partly by farther oxygenating them, the idea is suggested that we may aid this process by the internal exhibition of agents which contain a large proportion of oxygen in loose combination. Nitric acid answers to this description; and whether this be one mode of its action or not, I can affirm, from much experience in its use, that it is the best medicine that I know for the state of convalescence from inflammations. In doses of 20 to 30 minims, three or four times daily, in some aromatic or mild bitter vehicle, it often cleanses the tongue, and improves appetite, circulation, and strength. Its utility is limited by its tendency to irritate the bowels, but this result is rare. Products of external inflammation are sometimes more speedily dispersed under the influence of what are called discutients, which are generally slight stimulant applications, such as a warm spirit lotion, or solution of hydrochlorate of ammonia, common salt, or iodide of potassium; and, in more chronic cases, by friction with liniments containing mercury, iodine, ammonia, and spirit. These operate in various ways already explained, by promoting a free current of blood through the part without distension, and thus facilitating absorption; by diminishing the atonic congestion left by inflammation; by promoting secretion or exhalation; by pressure, &c. The restoration of a vigorous state of the circulation and excreting function is often necessary for the removal of copious effusions and deposits left by inflammations. Thus, I have noticed that pleuritic effusions frequently show no signs of dispersion until the strength of the body begins to return under a restorative mode of treatment. From the researches of Mr. Gulliver and others, it appears that the longer an inflammatory product remains without becoming organized, the more does it abound in particles or granules of a fatty character, consisting of margarine and oleine. This change, which is like that of atheromatous matter in arteries, and aplastic tubercle, probably depends on a spontaneous conversion like that which occurs in the formation of adipocire from fibrine kept moist, and secluded from the action of the air. To prevent such a result, and, perhaps, to disperse it where begun, we naturally look to means which increase the free circulation of arterial blood in and around the part; which, either by its oxygen or other solvent agents which it contains, may dissolve away the solid fats, and assist to disperse the solid deposits. This subject will be reviewed under the head of *Degenerations and Morbid Deposits.*

TREATMENT OF VARIETIES OF INFLAMMATION.

513. The *sthenic* (§ 477) form of inflammation requires the whole array of antiphlogistic remedies to be directed with energy against it. The prevalence of determination of blood, active vascular excitement, and the over-fibrinous condition of the blood, demand the free use of bloodletting, calomel, purgatives, and antimony at the onset; and the

full operation of mercury if the disease continue. In *asthenic* inflammation, on the other hand, bloodletting is ill borne, and often can only be practised locally; and the chief treatment is with antimony or mercury, and blisters, which, in the absence of high fever, may be employed at a much earlier period than usual. The diet, although light, must not be too spare, and may include such light nutriment as animal broths, milk, and farinaceous food. Mild stimulants may sometimes be required, especially ammonia, in order to enable the system to complete the processes of protection and elimination which are ever needed during inflammation (§§ 443, 4).

514. *Acute* inflammation (§ 478) demands a very prompt use of the suitable antiphlogistic remedies; but the choice made of them, and the extent to which they are to be pushed, will depend on whether the inflammation be sthenic or not. *Subacute* inflammation is generally of the asthenic form; and being less severe, as well as slower, in its progress and effects, it does not require such active treatment. It must not, however, be neglected; for its obscurity sometimes renders it dangerous; and, in an insidious manner, it sometimes seriously injures function and structure. Its long continuance, or liability to recurrence, renders it necessary to continue a moderate antiphlogistic treatment for several weeks. When lasting so long, it tends to become more asthenic, and the more lowering antiphlogistic remedies are no longer serviceable; and sometimes it is proper even to call in the aid of tonics and improved diet, whilst the local inflammation is treated with counter-irritants. Mercury, with opium, is generally one of the most useful remedies in subacute inflammation.

515. *Chronic* inflammation recedes still farther from the inflammatory type, and borders more on congestion or disease of nutrition. The absence of fever generally supersedes the need of the stronger antiphlogistic remedies—those for local inflammation being sufficient; general bloodletting is needful only when plethora also is present; and even local bloodletting should not be too freely employed; for it weakens the system, which is generally already too feeble in chronic inflammation. Counter-irritants are more constantly useful; and their application should be varied according to the seat and extent of the inflammation. In inflammations of serous membranes, a succession of large blisters answers best. For chronic inflammations of parenchymatous organs, and ulcerations of mucous membranes, counter-irritants, which excite pustules, or setons, are of more avail. Mercury is often useful, and so are other alterative medicines, especially salines, and the iodide of potassium. Mercury is more suitable to the more sthenic forms, attended with effusion of lymph, leading to tough thickening and induration of textures. Iodide of potassium is better adapted for chronic inflammation of an asthenic character, with reduced blood and strength, with tendency to ulceration, suppuration, or aplastic deposits. It is often requisite to keep up the general strength by the mildest tonics, such as sarsaparilla and mild bitters, and to allow a nourishing, but not stimulating diet, adapted to the digestive powers of the patient. Careful attention to the state of the excretions is particularly necessary. Courses of mineral waters and

change of air by gentle travelling, are often serviceable in chronic inflammations.

516. In *congestive* inflammation (§ 480), the treatment for congestion should be combined with that of subacute inflammation. If the subject be plethoric, general bloodletting would be proper; otherwise local bleeding and various derivants or revulsives, among which cupping and dry cupping, or hæmostatic ligatures (§§ 318, 503) are the most effectual. Rubefacient applications to an extensive surface, as large mustard poultices, and strong ammoniacal or mineral acid liniments, are of considerable efficacy; and their use can be renewed and varied daily for a long time. Mercury and antimony are both highly useful in the more active stage of congestive inflammations; the former especially for inflammations of the abdomen, the latter for those of the lungs. In the absence of much irritation, iodide of potassium, mineral acids, and even quinia, sometimes help to disperse the congestive part of inflammation. So, too, in secreting structures, as the liver, kidneys, and mucous membranes, various stimulants, which excite the secretion of the part, act in a similar way. In congestive inflammation, as in long-continued congestion, the blood suffers from long stagnation in the affected part, and, being spoilt (§ 191), may prove a cause of contamination to the rest of the blood in the body. Hence the propriety of using the various depurative remedies which increase the excretions, &c., and of resorting to iron, quinia, and nourishing food during the convalescence. For farther particulars, see the treatment of congestion (§ 313, *et seq.*).

517. The treatment of *phlegmonous* inflammation[1] is generally that for the sthenic form. *Erysipelatous* inflammation being generally asthenic, is not benefited by active antiphlogistic measures; and in some cases it is necessary to adopt quite an opposite treatment, by ammonia, wine, bark, &c.; this is where the influence of the specific poison (§ 482) predominates. In other cases, the reaction against this influence is very vigorous and requires moderation. Generally, warm fomentations to the affected parts, a saline, sometimes with small doses of tartar-emetic, and keeping the secretions free, answer best at first, and are, in a few days, to be gradually replaced by ammonia or wine, and bark or quinia, with improving nourishment.[2] A more decided counter-agent against the poison (as against other animal poisons) is a desideratum; but scrupulous cleanliness in all points, and careful regulation of temperature and ventilation, are the best preventatives in hospitals and sick rooms, where the effluvia from sores or wounds is apt to engender the disease. Punctures and incisions, which relieve the inflamed part by the discharge of blood and serum, cauterization by nitrate of silver, which by exciting a

[1] This term is used here in the sense in which Cullen employed it, as opposed to erythematic or erysipelatous. I mention this, because boils or furuncular inflammations are sometimes of an asthenic character; and with them not unfrequently the constitution requires support.

[2] Erysipelas of the head and scalp is that which falls commonly under the observation of the physician; and although often attended with formidable symptoms, I have very rarely known it prove fatal. All the cases (twenty in number) under my care at the hospital have recovered in a period varying from one to four weeks, under the general treatment recommended above, without any other local treatment than fomentations, where the patient likes them, very rarely a leech or two to the temple, and poultices to any succeeding boils.

different inflammation, arrests the progress of erysipelas—and mercurial ointment, which is supposed to modify its character—are the chief kinds of local treatment that have been found useful.

518. *Pellicular* or *diphtheritic* inflammation is usually of an asthenic character, little benefited by bloodletting, but chiefly to be counteracted by mercury, which is the suitable remedy for all inflammations effusing lymph; and by local astringents, or even caustics, which, by powerfully exciting the vessels, change their action. Thus nitrate of silver, in substance and in solution, hydrochloric and diluted nitric acids (one part to three or four parts of honey applied with a brush), and finely powdered alum, have been used with advantage in diphtheritic sore throat. In the croupy inflammations of children, the most effectual remedies are calomel freely used, antimony, and certain expectorant or attenuant medicines, which promote the more liquid secretions of the inflamed membrane. The aphthous inflammation of children is readily subdued by a solution of borax, or a weak solution of sulphate of zinc; using, at the same time, magnesia and mild mercurial aperients to correct the secretions of the alimentary canal.

519. *Hemorrhagic* inflammations (§ 484) are often of the congestive kind; and the hemorrhage arises from the excessive distension of vessels, as in the hæmatemesis that sometimes precedes gastritis, the bloody discharges of dysentery, and the hæmaturia which occasionally ushers in inflammation of the pelvis and tubes of the kidneys (pyelitis). The hemorrhagic tendency exhibited in purpura, and sometimes combined with inflammation in lichen lividus, and ecchymosed erysipelas, I have often found connected with congestion and torpid action of the liver (§ 171), and accordingly benefited by mercurial and saline aperients, followed by nitric or nitromuriatic acid.

520. *Scrofulous inflammation* (§ 485) being generally asthenic, is little benefited by bloodletting or other active antiphlogistic measures. Its disposition to produce early cacoplastic and aplastic effusions, makes it important that it should be subdued, if possible, at an early stage, in situations where the formation of curdy pus or tuberculous matter would be injurious. In scrofulous inflammation of the lymphatic glands, warmth and moisture and discutient applications (solutions of muriate of ammonia, iodide of potassium, warm vinegar) are often useful in dispersing the swelling before it comes to suppuration. In internal inflammations in scrofulous subjects, as of the lungs, glands, and joints, local depletion is generally advisable, followed by free counter-irritation, such especially as may cause an external discharge of pus. Dr. O'Beirne and others recommend a free mercurial course for scrofulous inflammation; but this I consider admissible only in the earliest stage of the disease, and in its more active forms; for I have found (what I believe is the experience of most practitioners) that mercurialization greatly injures the constitution of scrofulous subjects, degrades the products of inflammation, and promotes softening and ulceration in textures where deposit has already taken place. It seems to me that it is rather asthenic or chronic inflammation (§ 479), in subjects that are not scrofulous, that is benefited by mercury, and not that especially occurring in the scrofulous diathesis. Preparations of iodine, especially the iodide of potas-

sium, do sometimes appear to countervail low scrofulous inflammation; and their commonly salutary operation on the constitution renders them eligible medicines in scrofulous subjects.

But the source of the peculiarities of scrofulous inflammation, and therefore the chief object for peculiar treatment, is the scrofulous diathesis, or constitution; and as this seems to consist in a degraded condition of the plasma, or nutritive material of the blood (§ 211), often connected with a deficiency of red particles (§ 185), an invigorating and nourishing treatment and regimen are especially indicated (§§ 218, 219), and may sometimes be employed even when low inflammation is present; this being counteracted by counter-irritation or other local antiphlogistic measures. Hence the best remedies in scrofula are tonics, nourishing diet, and other means calculated to improve the nutritive function and general health. Even the medicine that has attained the highest repute in the treatment of scrofula, may be considered as belonging to the class of nutriments. I allude to the cod-liver oil, which has long been employed on the Continent, and in a few places in this country, and was highly recommended in a monograph published by Dr. Hughes Bennett, in 1841. Its general adoption has, however, chiefly depended on the ascertained fact that it is equally efficacious when purified by animal charcoal, which removes from it its offensive taste and smell, which are great impediments to its being borne by patients. Commencing with a dose of a teaspoonful thrice daily (two hours after each meal), and gradually increased to a tablespoonful, this medicine has produced in many scrofulous patients such improvement as quite to astonish me. It seems to give a new impulse to nutrition, for an amendment in flesh, color, and strength soon attends its use; commonly, the pulse is moderated, and even the appetite augmented, whilst more or less amelioration is generally manifest in the local inflammation. Thus scrofulous swellings diminish and even disperse; enlargements of joints are reduced; ichorous sores secrete a more laudable pus; the profuse discharge from abscesses and vomicæ is lessened; and consequently hectic fever, night-sweats, &c., are checked. The chief impediment to its use is its disordering the stomach and liver; the latter I have sometimes found to be remarkably enlarged during its exhibition. The utility of cod-liver oil in tuberculous disease, and its mode of action, will be considered under the head of cacoplastic and aplastic deposits. Of other medicinal agents, the iodides of potassium and iron, other preparations of iron, bitters with alkalies, bark, or quinia, and mineral acids, have been found the most serviceable. Equally important in the treatment are pure and mild air, especially near the sea or on mountains; warm clothing; regular exercise, friction, and other means to promote the superficial circulation; warm sea-bathing, or cold, when borne (§ 79), followed by friction; a good proportion of wholesome animal food, with due regard to the state of the excretions. These measures are of great efficacy in the scrofulous diathesis, and are often useful even after inflammation has produced disease; for they do much to prevent its increase, and assist nature in removing, or rendering inert, the cacoplastic or aplastic matter.

521. The peculiarity in the treatment of *rheumatic* and *gouty* in-

flammation consists chiefly in the use of means calculated to eliminate the morbid matter, which is its cause (§§ 251–254), from the system. The remedies which best promote this object have been already mentioned (§§ 252, 254). But it must be remembered, that the inflammation and fever excited may be so high and sthenic as to require active antiphlogistic measures before colchicum or mercury can be made to act; and this is particularly the case in acute rheumatism, in which inflammation is excited in many parts at once; and probably as a consequence (§ 438), the blood becomes surcharged with fibrine. Here general bloodletting is necessary, not to remove the cause of the inflammation, but the inflammation itself. If, after bloodletting, the rheumatic cause abound still in the blood, which is commonly the case, it is proper then to give colchicum with alkalies, or iodide of potassium, or nitre in large quantities much diluted (Gendrin), and to continue such remedy for some time, until the morbid matter shall have been sufficiently eliminated. In asthenic cases, the use of bark, quinia, or other tonics may be serviceable, in improving the tone of the vessels after the irritation and exhaustion which the disease and its treatment have produced (§ 174).

The infectious character of *gonorrhœa* and *syphilis* proves the specific nature of their cause; but it is only of the latter that we can speak of a specific remedy. How mercury cures syphilis is quite uncertain. It is not by any property directly destructive to the virus; for the disease cannot be prevented from appearing by mercurial action; and when present, it is not always cured by it. It is more probable that mercury acts as an alterative, by removing the callous indurations of syphilitic sores and swellings, and by increasing the secretions, and thus gradually eliminating the syphilitic virus from the system. It is now well known that other remedies, which promote absorption and secretion, also promote the cure of syphilis, especially the iodide of potassium. Gonorrhœal inflammation generally tends to a spontaneous cure in a few weeks' time; but this may be accelerated by mild antiphlogistic and demulcent measures at first, and astringent injections and terebinthinate remedies subsequently.

CHAPTER IV.

STRUCTURAL DISEASES, OR DISEASES OF NUTRITION—ULTIMATE AND PROXIMATE ELEMENTS.

SECTION I.

NATURE AND CLASSIFICATION.

522. ALTHOUGH we have had frequent occasion to advert to the changes in the process of *textural nutrition* effected by inflammation, congestion, &c., and although nutrition might be included under the head *secretion* (§ 178), a primary element, yet it has seemed better to defer the notice of diseases of nutrition until now; both because the previous consideration of disorders of the blood and its vessels gives the best introduction to them, and because we cannot strictly distinguish structural disease into ultimate and proximate elements. By analogy, indeed, we might infer that ultimate structural disease is that which affects elementary structures singly, such as muscular fibre, nervous matter, cellular texture, &c.; but we find structural disease rarely to be thus confined to one anatomical element, but rather to affect structures as they exist combined in more or less complexity.

It will not be consistent with the plan of this work to give full details of structural disease, which belong rather to the department of morbid anatomy. It will be sufficient for our purpose, to notice the chief forms of diseases of structure, by tracing them through the alterations in the function of nutrition which produce them. This method will enable us to class these diseases in an arrangement corresponding with that applied to the elements of functional disease (§ 104), and under each head to state briefly what is known with regard to their nature and origin, and the remedies which influence them.

As in the case of functional diseases, so of structural lesions, which are modifications of the function of textural nutrition, they may be comprehended under the three heads, *increased*, *diminished*, and *perverted* nutrition.[1]

[1] Although considerable advances have been made in pathological anatomy, and several new works devoted to the subject have appeared since the publication of the first edition of this treatise in 1843, it is satisfactory to me to find that in no material points has the advance of knowledge superseded the views there given of the elements of structural disease, but in many instances these views have been signally confirmed and extended. Under these circumstances, I have added to, rather than modified the text; and, in pre-

ELEMENTS OF STRUCTURAL DISEASE.

- DISEASED NUTRITION
  - Increased = hypertrophy.
  - Diminished = atrophy.
  - Perverted . . .
    - Induration.
    - Softening.
    - Transformation and degeneration.
    - Deposits
      - Euplastic
        - Cicatrices.
        - False membranes.
      - Cacoplastic
        - Cirrhosis.
        - Fibro-cartilage.
        - Gray tubercle.
        - Atheroma, &c.
      - Aplastic
        - Yellow tubercle.
        - Calcareous matter, &c.
    - Growths
      - Non-malignant
        - Cysts.
        - Tumors.
        - Hydatids, &c.
      - Malignant
        - Carcinoma.
        - Encephaloma.
        - Melanosis, &c.
- ALTERED MECHANISM
  - Contraction
  - Dilatation
  - Obstruction
  - Compression
  - Displacement
  - Rupture, &c.

It must be remembered that the division here given, simple as it is, is too precise to be rigidly applicable to many cases. Lesions of nutrition often graduate into each other, and are very commonly combined: hypertrophy of some textures frequently coexisting with atrophy of others, perverted nutrition being often combined with excessive or defective, and several of these different changes often occurring in succession in consequence of the operation of the same cause. We have already found this to be the case with the results of inflammation (§ 479); and inasmuch as that process exaggerates the changes of nutrition, it has furnished us with many examples of the production of structural lesions. What we now have to notice are those changes which take place independently of distinct inflammation, and which are mere modifications of the process of nutrition or reparation which is continually going on in the textures of the living body.[1]

523. As in inflammation, so probably in the ordinary process of nutrition, the material of which most of the organized solids are formed is the fibrine of the blood. This, by the formation of nucleated cells or nuclei of fibres, constitutes the basis of textures, which are afterwards farther modified by growth and multiplication, and by the deposition of homogeneous or hyaline matter in their interstices. Some structures are chiefly formed of the nucleated cells pressed together and consolidated in rows and layers, as in the epidermis and the epithelium

ference to new classifications and uncouth nomenclature, which it has been attempted to introduce from various foreign writers, I have retained my former division of the elements of structural disease, designated by terms in common use among British pathologists. For farther valuable information on details of morbid anatomy, I would refer to the works of Rokitansky, Vogel, and Lebert, especially that of Vogel, which Dr. Day has very ably edited for English readers. [Phil., reprinted, 1847.] It is much to be regretted that Rokitansky's work has not been rendered likewise accessible; for he seems to me to be the most accurate and experienced of all Continental morbid anatomists.

[1] For an able summary of our present knowledge on the subject of nutrition, see Dr. Carpenter's *Human Physiology.* 5th ed. [chap. xi. p. 546.]

of mucous membranes. In other textures, either cells are elongated into fibres, or primary fibres are developed in the blastema, as in fibrine; this seems to be the mode of development of filamentous, areolar, or cellular texture and its modifications, serous and basement membranes, fibrous and tendinous structures. In cartilage, the chief materials are peculiar cells contained in an amorphous solid, or an organized fibrous substance; in bone, radiated earthy particles occur in the place of cells. In the first formation and growth of textures, the production and multiplication of cells or nuclei from the plasma of the blood is necessary; and it is interesting to observe that in young animals, in pregnant females, and in the subjects of inflammation, the colorless corpuscles in the blood (§ 212), which probably are cell-germs, are much more numerous than usual (§ 418). But in the ordinary textural nutrition of adult animals, there is less need of the formation of new cells or germs; those already existing in the texture maintain the process by drawing nourishment from the blood-liquor, which furnishes the materials of all the solid textures; the formation of new cell-germs thus normally diminishes as age advances, and when then increased, it is usually the result of disease. Nutrition in all its stages is probably more or less a vital process: for although the chemical and physical formation of nuclei or cell-germs admits of imitation by the operation of minute granules of fat, or an albuminous fluid undergoing oxidation (§ 211), yet their progressive development, their growth into cells, their power of separation or secretion of certain matters from the blood-liquor, their power of self-preservation and reproduction, all are properties peculiar to living matter, and as such are to be regarded as ultimate facts or elements in physiology. When their laws shall have been more fully studied, we may hope to trace to these elements, varied in proportion and kind, corresponding elements in pathology, which will explain much that is at present obscure in the origin and nature of structural diseases. And we can already perceive, in a defect of these attributes of life, an element of malnutrition, in which the vital process of development fails in one or more of its stages, and renders the material unfit to form part of a living texture.

524. As nutrition depends on the blood for its material, and on the supply of arterial blood for the activity of the process, so it may be anticipated that changes of nutrition commonly arise from differences in the quantity and quality of the blood, and from variations in its arterial character. Hence diseases of nutrition are usually connected with diseases of the circulation and of the blood (§ 279), a moderately active circulation, and a rich blood favoring nutrition; a poor blood (§ 260), and either too active or too feeble a circulation, impeding it; and a diseased quality or proportion in the elements of the blood (§§ 186, 211) rendering it depraved. These causes operate on the whole frame; but they commonly affect some textures more readily than others, because the process of nutrition is naturally more active, and therefore is more speedily influenced in some than in others. Thus, fat and cellular texture are increased or diminished sooner than muscle, muscle sooner than tendon or bone, &c.; and, for similar reasons, degenerations and other changes of structure affect some parts more than others (§ 311).

But structural diseases are more commonly partial from causes existing in the part; and no causes are more common than those which affect the circulation of the part; so that partial anæmia, congestion, determination of blood, and inflammation are the most frequent causes of partial structural disease. We have made a similar remark of diseased secretion (§ 159) and other elements of disease. If the nervous influence affects nutrition, it is probably through its operation on the circulation of the part. Thus a paralyzed limb wastes, because, not being exercised, it is not so freely supplied with blood. The muscles of the limb of a frog, the nerves of which are divided, lose their irritability and waste also; but Dr. John Reid has shown that, by exercising these muscles by electricity, which promotes the circulation, both their irritability and nutrition are maintained.

SECTION II.

INCREASED NUTRITION—HYPERTROPHY.

525. Hypertrophy, as a disease, is always partial; for, although the whole body in cases of obesity acquires an enormous bulk, this is from the extraordinary growth of the adipose tissue, a part only of the frame. When the nutrition of textures generally has reached the acme of full health, there is no more increase, and the superfluous nutriment accumulates in the bloodvessels, causing plethora (§ 276).

[Although the development and growth of the body cease, as a general rule, at or about a determinate period—when the natural structures and full stature are attained—still, some parts grow to the latest periods of life, unless interfered with by disease. This is especially true of the heart and arteries. Dr. Clendinning and M. Bizot have shown, not only that the heart enlarges with advancing years, though with a decreasing ratio of increase, but that its weight augments, and the thickness of its walls increases, and it thus acquires power in the same proportion as it acquires bulk. Every part, too, throughout life, has the ability to grow, according to its needs, in proportion as its function is discharged. So long as the ordinary conditions obtain, after the attainment of the average size, each part merely assimilates; but when the conditions alter, and a part is necessarily more than usually exerted, it then manifests the ability of accelerating its growth—a reserve power of growth and development, put forward in moments of emergency.

The term hypertrophy is now used to designate excessive natural growth, unattended with the formation of any unusual product. Still, a distinction is to be observed between the increase of an organ by the uniform *growth* or enlargement of all of its tissues, and the increase by excessive *development* of some one. We have an example of the former in the thickening of the epidermis under the influence of pressure, friction, and other external forces. For though its rate of waste is augmented, it does not grow thin, but thicker, until it is completely

adapted to protect the cutis from the greater sources of injury to which it may be exposed under new circumstances. It puts forth its reserve-power, which is sufficient not only to repair all amount of waste but also to increase the quantity of the tissue to the amount required for the discharge of its increased functions. We see the same thing in the other tissues, particularly the muscles; as in a heart, for example, in which, from obstructed valves, the blood is held back in the organ; and the heart or one of its cavities necessarily acts with additional force. But, although the waste of an organ is commensurate to its exercise, there is no diminution of size, but, on the contrary, increase, or hypertrophy. But a part may do more than grow; it may develop itself, or acquire new structures for new functions it may be called on to perform. Examples of this are seen in the pregnant uterus, or when it is the seat of fibrous tumors; in the gall-bladder; or an obstructed ureter.

According to Mr. Paget, the conditions which give rise to hypertrophy, are three, namely: 1. The increased exercise of a part in its healthy functions. 2. An increased afflux of healthy blood. 3. An increased accumulation in the blood of the particular materials which any part appropriates in its nutrition, or in secretion. Examples of the first kind are furnished by the muscular system, particularly those of organic life—as the enormous thickening of the muscular fibres of the urinary bladder in cases of strictured urethra.

The increased afflux of blood to a part may be the cause, as well as the consequence of hypertrophy. The transplantation of the spur of a cock to the highly vascular comb is followed by the very rapid growth of that organ. The increased determination of blood to a bone, in consequence of partial necrosis, may give rise to hypertrophy of the entire bone.

The third cause is illustrated by the rapid increase in size of the kidney, when its fellow is incapacitated from performing its function.

For much valuable information on this subject, the reader is referred to the lectures of Prof. Paget,[1] which we have followed in the preceding remarks.—C.]

Hypertrophy may affect *individual textures* or *whole organs* composed of many textures; in the former case, it may be called *simple hypertrophy* (an ultimate element of structural disease); and in the latter, *complex hypertrophy* (a proximate element). Let us mention a few examples of each.

526. Muscles become enlarged by full exercise alternated with sufficient repose, and a healthy and well-nourished condition of the blood. This increased development in the voluntary muscles cannot be called disease; but I have seen it occur in the sterno-cleido-mastoid muscle, long the seat of convulsive motion; and, by giving too great power to the muscle, it seemed to perpetuate the distortion. The best cure for this would have been Dieffenbach's operation of dividing the muscle, as in the case of squinting, in which certain muscles gain too much power and probably bulk. But muscular hypertrophy is chiefly morbid when it affects involuntary muscles. Thus, in the heart, it results from con-

[1] Lectures on Nutrition, Hypertrophy, and Atrophy.—*Lond. Med. Gaz.* 1847.

tinued excitement in sthenic subjects; and from the violence with which the enlarged heart moves and propels the blood, it produces various bad consequences. The muscular fibres of the bladder become hypertrophied in case of enlarged prostate, or other cause of difficult micturition; those of the stomach are so from stricture of the pylorus; those of the bronchi become so in spasmodic asthma, and dyspnœa is the result. In these examples (as in all others of true hypertrophy), there is an increase of the amount of the proper tissue, that is, muscular fibres; in what mode these are produced, whether by new formation of cell-germs and subsequent elongation into fibres, or by splitting and growth of the original fibres, has not been ascertained.

527. Hypertrophy of the interstitial filamentous textures of the lungs, liver, &c., occurs after long-continued congestion from disease of the heart, &c. (§ 311). In the cellular texture of the lower extremities, it appears to be a chief constituent of elephantiasis. Hypertrophy of the epidermis occurs in callosities of the skin, and corns, from continued irritation or pressure, which causes determination of blood to the part. Another form of hypertrophy of the cuticle is that arising from chronic inflammation in psoriasis, chronic eczema, and impetigo. The cuticle is here retained, and, from its stiffness, it often cracks into chaps, or rhagades. In the more temporary or more superficial cutaneous flushes, congestions, or inflammations of erythema, scarlatina, lepra, and pityriasis, the superfluous epidermis is thrown off in a peeling of the skin, or in detached scales. But ichthyosis presents the most extraordinary instance of hypertrophy of the epidermis, its scales accumulating in a solid state, so as to form scales, or coarse bristle-like projections. These affections of the epidermis have their parallels in diseases of mucous membranes; but the secretions of these membranes being fluid, the nucleated cells, which on the skin would form solid scales, here are thrown off in the mucus, which presents an increased number of epithelium scales, as well as the mucous cells and a viscid amorphous fluid (§ 455). Such disordered secretion of the mucous membranes not unfrequently coexists with cutaneous diseases; thus, bronchial congestion with viscid secretion occurs in persons affected with psoriasis and lepra.

528. *Complex or hypertrophy of organs* of a healthy kind may result from a more copious flow of blood to them, contingent on their increased use. Thus, the uterus becomes hypertrophied in pregnancy; the breasts during lactation; one kidney becomes enlarged when its fellow is incapacitated by disease. The brain is more developed in proportion to the active exercise of the mind; and when this is carried too far, if inflammation, congestion, or some other vascular disorder do not occur, the brain may become hypertrophied, and by its bulk being too great for its bony case, it compresses the vessels, becomes indurated, and, as an obvious consequence, its functions are more and more impaired. Thus, in young subjects, who have been remarkable for precocity and activity of intellect, the brain has been over-nourished, and fatuity and coma have been the result. Mucous and cutaneous follicles sometimes acquire an extraordinary development after continued excitement, or without any such obvious cause. Bursæ become enlarged in situations exposed

to much pressure or friction, as on the shoulders of porters, the knees of housemaids, the elbows of miners, and the ankles of tailors.

The hypertrophy of the liver and spleen in protracted ague, may perhaps be referred to the frequent repetition and long continuance of the enormous congestions which this disease induces in these organs (§ 310). I have known a similar enlargement ensue after prolonged exposure to cold and wet. But in some cases, no such external cause can be traced; but the hypertrophy must be referred to a peculiar condition of the circulation of the affected organs, or to an unusual activity in their nutrient molecules. To this obscure category may be appended the case of enlargement of the thyroid gland in bronchocele.

The fatty enlargement or hypertrophy of the liver, and of adipose texture, may in many cases be referred to the reception of a large quantity of fat through the food, or a defective performance of those functions by which fat is eliminated from the system (§ 224); and in all respects the increase of fat may be viewed as less indicative of vital activity of nutrition, than of a predominance of its chemical material in the blood.

529. The *treatment* of hypertrophy must depend on the pathological cause which induces it. In most cases, this cause is some variety of hyperæmia, and the treatment suitable for the variety is to be employed (see Congestion, Determination of Blood, and Inflammation). But some remedies seem especially calculated to counteract the hypertrophy which these elements induce; such are iodine and its preparations, mercury, alkalies, and, in the more sthenic cases, sedatives and evacuants, together with low diet. The same remedies are occasionally useful also in hypertrophy less distinctly connected with hyperæmia, as bronchocele. In all cases, it is proper to attempt, as much as possible, to remove or counteract the exciting causes of hypertrophy, as by tranquillizing the circulation in hypertrophy of the heart; by soothing irritations of the stomach, bladder, &c., in obstructive diseases of these viscera; removal from malarious districts in case of visceral enlargements, &c.

SECTION III.

DIMINISHED NUTRITION—ATROPHY.

530. Atrophy, unlike hypertrophy (§ 525), may be a general disease; that is, all parts of the body may waste so much as to impair their functions. *General atrophy*, *marasmus*, or *emaciation*, consists in a removal of a considerable amount of the textures by decay and absorption, without a sufficient reparation by nutrition (§ 523). The organic materials of the body are not persistent, but are more or less prone to decay, becoming effete or worn out in a limited period of time; or as Dr. Alison expresses the same fact, the vital affinities which hold them together cease, and they become obedient to common chemical affinities which tend to their dissolution; the oxygen conveyed into the blood in respiration being a chief instrument in their decomposition. But in

the healthy body there is a reparatory process continually countervailing this decay, by the deposition of new materials whose vital affinities are energetic, and able to maintain the integrity of the textures (§ 523). Hence the causes of atrophy may be divided into the circumstances which promote decay, and those which impair or prevent reparatory nutrition. Among the former, may be counted various influences which greatly reduce the vital powers, such as excessive and prolonged exertion or excitement, want of sleep, extreme anxiety of mind, or continued suffering; under any of these, a person is familiarly said to be "worn to a shadow," without any more distinct disease taking place. But on examining the urine in such cases, it will often be found to contain an excess of urea, resulting from the decay of textures. This secretion is also sometimes alkaline, and unusually prone to decomposition; and the intestinal and cutaneous excretions sometimes exhibit an uncommon fetor, arising from the same tendency to putrescence. A fever of a low or hectic kind may be excited as a secondary result of these changes, and this fever is mistaken for the cause of the wasting. In cases of marasmus from excessive secretions or drains from the body, there is often also proof of accelerated decay; thus, diabetes mellitus reduces the body, not only by perverting and draining off its nourishment (§ 255), but also by promoting the decay of textures, which is manifest in the increased amount of urea excreted. Fevers and various acute diseases, attended with much excitement, in like manner exhaust the vitality of the textures and promote their decay, which takes effect especially as the disease declines, when the emaciation becomes most obvious.

The circumstances which impair or prevent reparatory nutrition are several, and may occur in any or all the steps of the nutritive process, from the reception of food into the system, to its appropriation and assimilation to the living textures. As examples in this series may be mentioned: 1. Defective quantity or innutritious quality of food (§ 58, *et seq.*); 2. Disorder of some part or parts of the digestive apparatus, such as extreme dyspepsia, diarrhœa &c., which prevent the formation of chyle; 3. Diseased mesenteric glands or tumors obstructing the thoracic duct, intercepting the supply of chyle to the blood; 4. Perversion of the assimilating process by which chyle is converted into blood (§ 253), as in diabetes mellitus and chylosus; 5. Defect in the formation of fibrine (§ 196) and albumen (§ 221) of the blood, the materials of nutrition; so that, instead of becoming the plastic material for repairing the texture, they have a tendency either to pass into decomposition, as in malignant fevers[1] (§ 257), or to concrete in a cacoplastic or aplastic form, as in

[1] My friend, Dr. Hodgkin, considers a suspension of textural nutrition to be a chief cause of the phenomena of fever, and has very ingeniously applied this notion to explain many of the symptoms.—*Lectures on Morbid Anatomy of Serous and Mucous Membranes*, vol. ii. p. 490. Rokitansky, and other German pathologists, consider that typhoid fevers depend on the production, in the body, of an organic matter having some resemblance to malignant formations. To this, they apply the term typhus-material, and indicate the follicles of the intestines, and the parenchyma of the lungs, as the chief places of its deposition. Under the microscope, however, this matter exhibits nothing to distinguish it from bad fibrine or cacoplastic lymph; and in accordance with the view in the text, I consider it to be such, and tending to involve in a process of sloughing the excretory

tuberculous diseases; 6. Excessive discharges of various animal fluids, of blood, pus, serum, milk, semen, mucus, &c.; or morbid growths, which monopolize the nourishment of the body, such as tumors of various kinds, particularly cancer; 7. Parasitical creatures, such as hydatids, worms, &c.

531. A consideration of the above list of causes of emaciation, will show how uncertain it is as a symptom if it be taken alone; but when traced to its cause, it is a very important index of the amount to which that cause operates on the living body. Emaciation will rarely continue or advance to an extreme degree, without structural changes which render the cause permanent; hence, extreme marasmus is generally connected with tuberculous disease, carcinoma (especially of the

follicles of the intestines by which it is attempted to be thrown off, or inducing a deposit in the lung, which has various pernicious tendencies (§ 474).

[Rokitansky, Vogel, Engel, and most of the German pathologists, describe the "typhus-material," and believe it to be an important pathological element in most cases of typhus. It occurs, according to them, as a more or less firm lardaceous mass of a yellowish or whitish color, deposited, most frequently, in the intestinal canal, between the mucous and muscular coats, in Peyer's glands, and in the mesenteric glands; less frequently in the spleen and lungs, and in and under the mucous membrane of the trachea, and in the bronchial glands. Dr. H. Bennett, in an interesting paper on the morbid appearances of typhus, as it occurred in Edinburgh in 1846 and 1847, published in the *Edinburgh Monthly Journal*, for 1847, found the typhous deposit in the lungs, spleen, and intestinal canal; and confirms the views of the German pathologists.

It may be either in a fluid or solid form. Engel says, the "fluid matter is a viscid opaque, greenish-brown material, which, when allowed to remain at rest for some time, deposits an abundant sediment of epithelial cells, crystals of ammonia-phosphate of magnesia, and brownish flocculent coagula, whilst the fluid itself remains of a brownish or reddish color, and contains a considerable quantity of albumen; it undergoes no other change than that of decomposition. The solid portion of the typhous product appears in the solitary and Peyerian glands of the small intestines, in the follicles of the large intestines, and in the mesenteric glands; it assumes the forms of these various parts in which it occurs, has a soft, pulpy consistence, a grayish-red color, and appears, shortly after its deposition, as a finely granular substance, mixed with blood-corpuscles, and seems to be chiefly composed of albumen.* Examined beneath the microscope, Vogel found this substance appearing 'as an amorphous, slightly granular mass, of a brownish-white color, within which a large quantity of small-sized cells were deposited. These cells had an irregular roundish form; the majority were below 1-300th of a line in diameter; a few measuring from 1-150th 1-200th of a line; some were distinctly nucleated. By treatment with acetic acid, the amorphous substance became transparent, and gradually disappeared, upon which, very small cells (cell-nuclei?) with sharp outlines came distinctly into view, being unaffected by the acid. Both cells and blastema were dissolved by ammonia and by caustic potash. The glands of the colon contained a substance exactly similar to that found in the mesenteric glands, and in those of the small intestines.' "†

Dr. Bennett says: "The minute structure of the typhous deposit varies in different situations. In the lungs, spleen, and intestinal canal, it contains, at an early stage, a number of roundish or irregularly-shaped corpuscles. They are about the 100th of a millimetre in diameter, contain several granules, with a nucleus about the 500th of a millimetre in diameter. Acetic acid renders them more transparent. They are conjoined with numerous granules and molecules, which become more abundant as the process of softening advances. In the mesenteric glands, a higher degree of cell-formation takes place. Cells are formed about the 50th of a millimetre in diameter, containing from two to six, and sometimes even more nuclei, which become very distinct, with thick edges, on the addition of acetic acid, whilst the cell-wall is partially dissolved. The same cells may occasionally be seen in the elevated typhous deposits of the intestinal glands. Sometimes, the only appearance observable in the deposit, is that of numerous molecules and granules mixed with blood-corpuscles."—C.]

* Schmidt's Jahrbücher, No. 7, 1845. Lond. Med. Gaz. vol. xxxvi. p. 1216.

† Clymer on Fevers, p. 237. Phil. 1846.

stomach), or some serious organic disease. The chief exception to this is diabetes, the intractable persistence of which is involved in much obscurity.

532. *Partial atrophy*, the reverse of partial hypertrophy (§ 528), commonly arises from defective supply of blood to the part. Sometimes, the defective supply is from the disuse of the part; thus the eye wastes, in confirmed blindness; muscles and whole limbs become atrophied from disuse, in paralysis and anchylosis; the testicle and the mamma waste with age, &c. Frequently, partial atrophy in an organ succeeds the changes induced by inflammation or other structural disease; the matter effused swells some parts, compresses others of the texture, and, by preventing a due supply of blood, causes a subsequent atrophy. This is especially the case when the products of inflammation or congestion are cacoplastic, as in cirrhosis of the liver, and granular disease of the kidney, in the consolidation of the lung caused by pleuro-pneumonia, &c.; the deposits here produced, tend to contract and compress the vascular structure, and thus deprive the organ of its nourishment; it accordingly shrinks in size, or, in the case of the lungs, the texture may become thin and emphysematous. In chronic pneumonia and phthisis, also, many bloodvessels in the lung become obliterated, and the texture may either waste or farther degenerate, according to its condition. Atrophy of the heart and brain have sometimes been found connected with ossification and partial obstruction of the arteries supplying them. The dwindling of limbs in children, and the lameness in old persons from shrinking of the neck of the thigh bone, appear to depend on similar impediments in the vessels supplying the parts.

[Mr. Curling has shown that atrophy may occur in that portion of fractured bones which is cut off from the direct supply of blood through the great medullary artery. It will be shown presently (§ 545), that *fatty degeneration* is very frequently present in cases of atrophy, though in such cases the diminution in bulk is slight or null. Atrophy of the muscular tissue may depend on a deficient production of motor power in the nervous centres. Dr. Carpenter gives an interesting example of this in the last (5th Am.) Edition of his *Principles of Human Physiology*. He says that he has had under his observation three males of a family who have "progressively become affected, between the ages of three and five years, with fatty degeneration of the muscles, which has proceeded in the most advanced case to the almost complete obliteration of their normal structure. This change had been considered by many eminent practitioners to be idiopathic, that is, to have its primary origin in the muscular tissue; and the measures which had been employed to arrest it had been of no avail whatever. It was a strong argument, however, against such a view of the case, that, in the *heart* of the eldest son, who died of fever at the age of sixteen, no fatty degeneration could be discovered; and on making inquiry into the history of the parents and their families, ample evidence was discovered for the belief that the disease was dependent upon want of functional power in the nervous centres. Acting on this view, it was recommended that the muscular system should be kept as much as possible in a state of active exercise, and that a weak galvanic current should be frequently transmitted through the

limbs from the spine. This treatment has proved so far successful that the progress of the disease appears to have been arrested in the most advanced case, whilst a decided improvement has taken place in the condition of a younger child, who was previously passing rapidly into a state resembling that of his elder brothers."—C.]

533. The *treatment of general atrophy* (§ 530), must be directed to remove or obviate the cause, where that is practicable, to supply proper and adequate nourishment, and to promote the healthy action of the digestive, assimilatory, and circulatory functions. The means of fulfilling these indications, where attainable, would require too lengthened a detail to be introduced here; it must suffice to mention the chief remedies and measures to be opposed to the several pathological causes of atrophy.

Atrophy, from excessive or prolonged exertion, is to be treated by a sufficient amount of rest and nourishment, with wine or other stimulants also, if exhaustion still prevails (§ 84); that from anxiety of mind, suffering, or sleeplessness, by various medicinal narcotics and change of air and scene, as well as by measures calculated to soothe under the particular circumstances. The effect which opiates and other narcotics sometimes have in diminishing the urea excreted in such cases, points out that these remedies tend to control decay, and they may in some cases be aided by mineral acids and various tonics. The same remedies are useful in diabetes mellitus, the marasmus of which is, however, to be still farther checked by withdrawing *all* articles of food that can be converted into sugar—that is, all farinaceous, amylaceous, saccharine, and gelatinous matters (§ 256). I have generally found the excessive discharge and the emaciation of diabetes to be effectually controlled by the full application of this rule, but never by its partial observance, as recommended by Dr. Prout.

The counteraction of the circumstances which impair or prevent reparatory nutrition (§ 530), comprises the treatment of the several diseases and causes of disease before enumerated under the seven heads, which it is not necessary to recapitulate. In most of these, the use of food as nourishing as the stomach can digest, and of tonics, medicinal and hygienic, as bracing as the body can bear, with due attention to the regularity of the excretions, affords the best chance of resisting or retarding the emaciation; and their utility will much depend on the judgment with which they are applied. The utility of fat in the process of nutrition has been several times pointed out (§§ 66, 211, 224), and in addition to a fair allowance of milk, butter, and fat in food, or instead of them where they disagree, the cod-liver oil is a valuable remedy in atrophy. It is most suited to scrofulous cases, but I have experienced its utility in convalescence from fevers, and from prolonged and wasting attacks of rheumatism.

534. As *partial atrophy* often arises from defective circulation in a part, it may sometimes be counteracted by measures calculated to promote the passage of blood through that part. Thus, muscles wasted by disuse are sometimes increased and strengthened by blisters, stimulant frictions, electricity, and exercise. Atrophy following inflammation or congestion may sometimes be advantageously opposed by the remedies

for the results of these conditions, especially iodine in combination with tonics, as iodide of potassium and sarza, iodide of iron, &c. In this and most other cases of structural disease, although treatment can do little to remove partial atrophy already induced, yet it may sometimes retard its increase by restoring a more healthy circulation throughout the body.

[It has been ascertained by the experiments of Dr. John Reid,[1] that the atrophy of paralyzed muscles is due to their disuse, and that their nutrition is sustained when they are artificially stimulated to action. Mr. Paget, in the excellent lectures before quoted, observes that, when a person has had hemiplegia, the paralyzed limbs remain incapable of action long after the brain has, to all appearances, recovered its power. This abiding paralysis is not the consequence of any continuing disease of the brain, but should be ascribed to the imperfect condition of the muscles through inaction. So long as the state of the brain makes voluntary action impossible, the muscles are suffering atrophy; then, when the brain recovers, they are not in a state to obey its impulse, they are degenerate; and their inaction continuing, they degenerate more and more, and finally never recover their function. We ought, when muscles are paralyzed through disease of the nervous centres, to give them artificial exercise; as exciting the reflex movements—by electricity and other means, which will insure their nutrition, and when the nervous system recovers they may be in a condition to act under its impulse. It has been suggested[2] that, in cases of hysterical paralysis, in which the condition of the nervous system suspends, for a time, its functional influence over the muscular parts, and in which there is every reason to hope that this influence will, in some way or other, be restored, this treatment may prove especially applicable.—C.]

PERVERTED NUTRITION.

535. Under this head are comprehended all those changes of textural nutrition that go beyond mere degrees of *plus* and *minus* in the natural molecules of the textures; they either alter the *quality* of the texture, or form new textures, growths, or deposits, in connection with the normal texture. These changes often comprise partial hypertrophy and atrophy as well; and in so far as they do so, the observations already made with regard to those elementary changes may be extended to these, but with new additions.

SECTION IV.

INDURATION AND SOFTENING.

536. We have mentioned both *induration* and *softening* to occur as the results of inflammation; softening being commonly connected with

[1] Edinburgh Monthly Journal of Medical Science, May, 1841.
[2] British and Foreign Medico-Chirurgical Review, vol. i. p. 423.

the increased secretion and absorption occurring in acute inflammation (§ 427); or during the dissolving process of suppuration (§ 461); and induration being rather a sequel of the more chronic kind, which causes a continued overflow of the solid nutritive matter (§ 479). Both these changes sometimes take place independently of complete inflammation; but they probably, in most cases, depend on some of its elements.

537. *Induration* is constituted by an increased deposit of solid matter in a structure, or by compression of that structure, or by both. In some cases of insanity, the inner table of the skull acquires the hardness of ivory. In newly-born children, the skin acquires an unusual hardness and rigidity, rendering them "skin-bound." Glands and other soft compound structures sometimes become hard without inflammation. Probably, in all these cases, there is prolonged determination of blood to the parts, which causes an exaggeration of the nutritive function; but the matter exuded is more hyaline (§ 523), or simply granular (§§ 452, 3), than consisting of highly organized cell-germs or fibres; hence the result is not simple hypertrophy or increased growth, but a more condensed and more uniform texture. A somewhat similar change is produced in the lung by compression by liquid effusion or a solid tumor, especially when the lung itself is also inflamed, as in pleuro-pneumonia, in which the pressure restrains the full development of the exudation corpuscles. The induration of cartilage, &c., by osseous deposit is more properly transformation than simple induration. So induration of the liver, kidneys, and other organs, generally comprises intestinal deposits, and other changes of structure.

538. *Softening* arises from different causes in different textures. In some instances, the cause, being peculiar to the structure, may be called specific. Thus, in the bones, it proceeds from defective deposition of phosphate of lime, the earthy matter which gives solidity to these structures.

[Mr Paget believes that the disease which most English writers have described as Mollities Ossium is really a fatty degeneration of those bones. Mr. Hunter's description of a softened humerus confirms this opinion. He says "the component parts of the bone were totally altered, the structure being very different from other bones, and wholly composed of a new substance resembling a species of fatty tumor, and giving the appearance of spongy bone, deprived of its earth, and soaked in soft fat."[1] Mr. Paget has not, from any specimen of mollities ossium which has come under his notice, been able to agree to the general notion of the nature of the disease, which refers it to the removal of the earthy matter of bone, and the reduction of any part of the skeleton to its cartilaginous basis. He has found, as the chief features of the structural change, softness and brittleness of the bones, with the presence of a large quantity of adipose matter, resulting apparently from the conversion of the cartilaginous basis into fat. Flexibility and tenacity would rather be the conditions, if the calcareous matter were deficient, and the cartilaginous basis normal. Rokitansky has described, under the name of osteomalacia, malosteon, rachitismus adultorum, an

[1] Catalogue of the Pathological Museum of the College of Surgeons, vol. ii. p. 28.

affection of the bones of the trunk, occurring especially after childbirth, which coincides in its character with the ordinary ideas respecting mollities ossium. Similar cases of this kind have been published recently by Mr. Dalrymple and Dr. Bence Jones. So that, as Mr. Paget observes, there are probably two diseases included in the name of mollities ossium—the fatty degeneration, and the simple softening of bones.[1]—C.]

The softening of the stomach found after death is caused by the solvent action of the gastric juice. The softening of various textures, especially muscles, in fevers and other cachectic states, is connected with a defect of fibrine in the blood (§ 196); the same cause which removes this fibrine, and prevents its formation (§ 216), apparently dissolving or loosening the fibrinous parts of solid textures. In several cases of cachectic diseases in intemperate persons, commonly with degeneration of the liver and kidneys, I have found after death a general softening of the textures, which, under the microscope, exhibited an unusual predominance of oil-globules (§ 258). In other instances, softening is a variety of atrophy, arising from a defective supply of blood; so that the texture of a part decays, and is absorbed away faster than it is repaired. Thus softening of the brain and heart is sometimes found connected with ossification and partial obstruction of the arteries supplying these parts. Softening of the affected muscles sometimes accompanies paralysis, especially that from lead. In a few instances, partial softening, like atrophy, follows inflammation, and is to be ascribed to the obstruction of vessels which that affection has produced. Thus softening of portions of the brain occasionally follows meningitis; softening of the heart succeeds to pericarditis; softening of the stomach and intestines occurs after some kinds of gastro-enteritis; softening of the articular cartilages sometimes succeeds to their inflammation.

In all cases of partial softening, although the chief cause is local, yet a non-fibrinous or aplastic condition of the blood materially assists in promoting this result; and it is a serious question whether the continuance of antiphlogistic measures and abstinence does not occasionally promote this consequence of the changes of inflammation. Some of the most distinct cases of softening of the heart and brain that I have met with, have been those in which the patients have been long kept in a reduced state, for fear of return of inflammation of these organs.

539. Induration and softening being opposites of each other, although sometimes preceded by similar causes, require in some degree parallel modes of *treatment*, but in an opposite way. Induration consisting of condensed hypertrophy, and often arising from prolonged determination, may be counteracted by partial antiphlogistic measures, especially those tending to remove obstructions and deposits (§§ 511, 515). Thus mercury and iodine, externally and internally used, and alkaline saline medicines, are supposed to have some power in discussing hard swellings; and setons, issues, or suppurating counter-irritants, which draw away blood and nutriment from the indurated part, may be found in some cases useful. But extreme antiphlogistic or reducing measures

[1] Paget's Lectures, &c. *loc. cit.*

are not indicated (§ 218), inasmuch as induration itself implies a degraded kind of the nutritive material (§ 537), and does not result from acute or sthenic inflammation.

540. In cases of softening that are not specific (§ 538), the indications of treatment are to restore a more fibrinous or plastic state of the blood generally, and to improve the circulation in the atrophied part. In fevers and cachectic states, where the softening is general, the first is the chief indication, and some of the means of fulfilling it have been already noticed (§ 216). Besides nourishing food, and agents which improve the digestion and circulation, tonics and stimulants are often useful. How far the operation of mineral acids, bark, and other tonics depends on their astringent or bracing influence on the animal fibre, we cannot undertake to determine; but after fevers, and in cachectic states, they do appear to improve the substance and firmness of the solids, in a way more direct than by merely exciting the circulation, and ameliorating the condition of the digestive organs. So, too, the operation of stimulants, both local and general, probably goes beyond that of accelerating the circulation, and determining blood to parts where it is ill supplied; it probably also increases the production of fibrine and cell-germs from the albumen of the blood, just as we see this to result from the application of stimulants before they cause inflammation (§§ 294, 415). The relief sometimes afforded to the symptoms of softening of the brain and heart, after all inflammation has ceased, by mild stimulants, tonics, and a moderately nourishing diet, is too little known to those who have always the dread of inflammation before their eyes, and who yet forget that a chief evil of inflammation is the injury it inflicts on function and structure, which injury often lasts when the inflammation is gone or is of trivial amount. The beneficial effect of nourishing diet and stimulant applications on soft flabby ulcers, is another illustration in favor of this kind of treatment in cases of internal disease, where the general weakness, apyrexia, pallidity, and muscular emaciation, much preponderate over the symptoms of local irritation. A chief part of the benefit arising from the use of stimulants and tonics, may be fairly traced to their promoting the healthy formation of blood, and an increased vigor of circulation; but there are some agents which seem to augment the plasticity of the blood, and which have no remarkable tonic powers. I allude to nitric acid, nitro-muriatic acid, and chlorate of potass, the power of which, in promoting the healing of cachectic or spreading ulcers, is very remarkable; and I have obtained much advantage from the use of these medicines in various cachectic states following prolonged acute disease or habits of intemperance. It seems most probable that these agents are chiefly useful in supplying to the blood the oxygen necessary for the formation of fibrine (§ 211) or deutoxide of proteine; the respiration in its weakened state being inadequate to furnish a due amount. On a similar principle, the purest air, and such exercise or friction as may tend to make the respiration and circulation more effective, are beneficial in these cachectic states.

541. The treatment of the specific example of softening found in the bones, is not well understood. The circumstances which promote or impede the deposition of phosphate of lime in the bones, are not clearly

known; but measures of a tonic kind, with appropriate nourishing diet, have been found distinctly useful in rickets in children. The mollities ossium of adults, is a still more obscure and intractable affection. The formation of callus at the ends of fractured bone, and the completion of the ossific process in it, are promoted by generous diet and tonics.

SECTION V.

TRANSFORMATION AND DEGENERATION OF TEXTURES.

542. When one elementary texture, as muscle, is replaced by another, as fibrous, it is said to be *transformed.* The term *degeneration* is also generally applicable to this change; for the new texture substituted for the old is most commonly lower in vital properties. The chief exceptions are in the case of skin being transformed into mucous membrane, when by anchylosis of a joint, an external surface is brought almost to the condition of an internal; and the converse case of transformation of mucous membrane into skin, as in long prolapsed uterus. In these instances, the changes appear to arise from the physical condition in which the membrane is placed; the exudation corpuscles remaining soft and moist, and becoming epithelium scales and mucous globules in one case, and drying into epidermis in the other.

Muscle is sometimes transformed into fibrous or fibro-cellular texture, in some cases after inflammation of contiguous parts. Loss of substance in muscles, from wounds or ulcers, is generally replaced by a similar fibro-cellular texture, and never by new muscles.

543. Animal textures are liable to various kinds of degeneration; four of which may be particularly specified as having very distinctive physical and chemical characters; namely, the *fibrous*, the *granular*, the *fatty*, and the *osseous*, or *calcareous*. All present the characters of deterioration or degradation in the scale of living textures, which the term degeneration is meant to imply; and they do so in degrees corresponding with the order in which we here arrange them. In chemical composition, and in a fainter degree in their physical condition, they analogically present a successive descent from animal to vegetable and mineral substances.

Fibrous degeneration chiefly affects muscular structures, especially when inflammation has existed long in or near them. Thus parts of the muscular fibres of the heart have been found converted into a dense fibrous tissue after endocarditis and pericarditis; those of the limbs after prolonged fascial rheumatism; those of the intercostal muscles and diaphragm in chronic pleurisy. Age works a similar change, as displayed in the tough and sinewy condition, with wasting of size, of the muscles of old animals (§ 48). The fibrous tissue thus developed resembles that existing naturally in the tendinous and fibrous structures of the body, consisting of closely knit bundles of fibres, but with a scantier distribution of nuclei, and very few bloodvessels pervading them. The fibres are usually also coarser, and here and there present granular irregulari-

ties. They often tend in time to degenerate into the other forms of degraded animal substance, the granular, fatty, and osseous. In chemical composition, they belong to the group of gelatigenous tissues. Several parenchymatous organs, the spleen, the liver, the kidneys, and the lungs, sometimes present a change which seems to amount to a fibrous degeneration, a dense filamentous tissue pervading and more or less superseding their natural structures; but as in all these instances there is a great increase in the density of the organ, it is more correct to view the new fibrous material in the light of an interstitial deposit, than as a transformation of the proper textures. This will be considered under another head.

544. *Granular degeneration*, as commonly met with in organs, is, like that just noticed, the result of a cacoplastic deposit effused in the interstices of a texture, and exhibiting more or less of a granular composition. But this same appearance is sometimes exhibited in textures under the deteriorating influence of malnutrition, chronic inflammation, and old age, without any augmentation of substance. We have just noticed that morbid fibrous tissues sometimes tend to this result. The same change may invade natural fibrous and elastic tissues, especially of the vascular system, impairing their cohesion and transparency, and rendering them liable to extension, laceration, and rupture; or constituting the first stage of the farther degeneration into fatty or calcareous matter. Under the microscope, the structure presents a remarkable increase of aggregated granules, with a corresponding diminution of the fibrous or filamentous tissue. The granules are not highly refractive, and there are no free oil-globules; in this respect it differs from fatty degeneration; neither is it so opaque or fragile as the true fatty atheroma. It is probably a condition intermediate between fibrous and fatty or osseous degeneration; and I have repeatedly found it in an artery which presented both these changes. Its chemical composition is uncertain; but probably it is either gelatigenous or albuminous, with an increase of fat in the form of molecules. Cacoplastic deposits and recent lymph sometimes degenerate in this mode.

[Mr. Paget has recently described[1] a pathological condition of the heart, not previously recognized, under the name of "granular degeneration" of its muscular tissue. In this, there is neither any evident deposition of fat, nor is there that mottled appearance which indicates complete local fatty degeneration in spots or lines of the muscular tissue. "The whole organ has its natural shape, size, and general external appearance; but it feels soft, doughy, inelastic, unresisting, and may be moulded and doubled up, like a heart beginning to decompose, long after death; it seems never to have been in the state of *rigor mortis*. These appearances are more manifest when a section is made through the wall of the left ventricle. Then, if the wall be only partly cut through, the rest of it may be very easily torn, as if with separation of fibres that only stick together; and the cut surface of the wall looks, as it were, lobulated and granular, almost like a piece of soft conglomerate gland,

[1] Lectures, &c. *loc. cit.*

—an appearance which is yet more striking when observed with a simple lens of about half an inch focus. In color, it has not on its surface, much less on its section, the full ruddy brown of healthy heart, a color approaching that of the strong voluntary muscle; but it is, for the most part, of a duller, dirtier, lighter brown, in some parts gradually blending with irregular marks, or blotches, of a paler fawn color." When microscopically examined, the fibres are found to show a remarkable tendency to transverse cleavage; very minute oil particles are seen in their interior; and no nuclei are found lying among them. In three cases in which Mr. Paget has observed this form of fatty degeneration, death was very sudden, and was not preceded by any symptoms indicative of imperfect action of the heart. It may proceed silently and gradually, undermining the power of the entire heart, yet not rendering itself apparent by any functional change during the ordinary events of calm and quiet life; but the individuals thus affected are wholly unable to resist the storm of a sickness, or the shock of an accident, or an operation. It is very probable that many cases of sudden death, not otherwise accounted for, have been due to this cause; for a structural change of this kind may have advanced so far as to be sufficient to destroy life, without being perceptible to any but a very careful and practised examiner.—C.]

545. *Fatty degeneration* was long since described by Laennec as affecting the muscles, liver, and some other structures. It is to be distinguished from fatty accumulation, which is hypertrophy of the natural adipose texture, or fat-cells, and which may by its bulk press on textures, and cause their wasting. True fatty degeneration consists in the formation of fat in the proper tissue of the part; thus, in fatty degeneration of muscles, the fibres themselves become pale in patches or spots, and under the microscope exhibit fatty globules or crystals within the sarcolemma; and as the change increases, the color and consistence of the muscle are impaired, and its power proportionately weakened. This change has been found in the heart, and in some voluntary muscles, under circumstances somewhat like those which promote the fibrous degeneration of the same textures; but apparently in connection with still weaker constitutional powers, and other evidences of malnutrition. In the same cases, as well as in others, the arteries exhibit the atheromatous patches which Mr. Gulliver has proved to consist of fatty matter, which appears to be partly formed at the expense of the middle coat, and partly deposited in a granular and globular form under the inner lining.

Fatty degeneration of the liver is characterized by a pale opaque appearance of the viscus, its soft greasy consistence, its low specific gravity (sometimes floating in water), and by its greasing paper when heated upon it. Mr. Bowman pointed out that the liver-cells naturally contain a considerable proportion of oil-globules; and he suggested that fatty degeneration might depend on an increase of this normal constituent, so great as to press on and cause the atrophy of the other tissues. It has been surmised that this fat is the bile, in the process of its formation by the secreting cells; and that its increase, in phthisis, is due to the additional task thrown on the liver to excrete from the system the hydrocarbon,

which the lungs in their disabled state cannot remove. If this were true, fatty degeneration of the liver would occur more constantly in phthisis and other diseases of the lungs than we find to be the case. I have met with it chiefly in females in whom emaciation has proceeded with great rapidity; and I should rather ascribe it to the arrest of the fatty matter which is taken into the blood during the rapid decay of the textures, and conveyed to the liver as the proper excreting organ of such materials. It is also possible that the fatty matter which is formed in tubercle, during its process of maturation and softening, may be conveyed into the circulation, and contribute to this change in the liver.

[Mr. Paget also dissents from the explanation of the disease generally admitted. He gives the following reasons against it: 1. The connection between fatty liver and disease of the lungs is not general. In many who die phthisical, the liver is healthy. 2. There is no evidence derived from examination of the feces, that the fatty liver does secrete an unusual quantity of carbon and hydrogen. 3. If the carbon and hydrogen, supposed to be formed in extra quantity in the liver, be not in the feces, then the lungs would only be damaged by the excessive formation of those elements in the liver; the function of the liver, in warm-blooded animals after birth, being chiefly preparatory to that of the lungs. And 4. All the conditions of the fatty liver show that it is an inactive organ, one which is discharging less than its ordinary function, and the less, the more general the fatty degeneration of its cells. This is indicated by the analogy of all fatty degenerations, the absence of nuclei in the fatty cells, the absence of all appearance of the coloring matter of the bile in them, the large size of the liver (indicating a tardy or obstructed removal of its cells), the paleness and defective supply of blood, and the frequent coincidence of other morbid changes, such as would naturally hinder the proper activity of the organ. We have, too, a corresponding change in the kidney, presently to be noticed, with no excretion of fatty matter, and a diminished excretion of the proper materials of the urine.—C.]

But fatty transformation occurs in other organs and tissues so commonly as to show that it must arise from some chemical tendency in animal substances, independent of the function of any particular organ. Thus, we have already (§§ 223, 258, 538) noticed several instances in which fat-globules are found in increased numbers in various organs of the body, without any marked development of the common adipose textures. This has frequently occurred in the bodies of persons who have been habitually intemperate, generally with more or less disease in the liver, with or without jaundice; but I have met with a few such cases in cachectic subjects, who have not been addicted to excesses, and in these most commonly the urine has been albuminous, and the kidneys have exhibited more or less of the degeneration described by Dr. Bright. In all these examples, all the viscera which I have examined have presented an unusual predominance of oil-globules, with some degree of softening and opaque yellowish pallidity, common to ill-nourished tissues; the liver, spleen, kidneys, and even the muscles, having a dingy red, or yellowish brick hue, instead of their proper colors. The increase of oil-globules in the epithelium cells of the kidney has been

particularly noticed by Dr. George Johnson, who considers it to be the primary pathological change in Bright's disease of the kidney, corresponding with fatty degeneration of the liver; and he ascribes the impaired function and wasted structure of the organ to this accumulation of fat. But although I admit the presence of numerous fat-globules in certain forms of degenerated kidney (indeed, I had described it, before Dr. Johnson made his researches), I have never seen in the kidney anything at all approaching to the condition of the fat liver, in which both cells and interstitial textures are completely glutted with oil-globules.

In fact, the same increase of fat-globules which, in these cases, is noticed in the kidney, is found in other textures, and is the result of malnutrition, which tends to convert other animal substances into fatty matter. A similar tendency is manifest in the products of inflammation and other deposits. Thus, the opaque exudation corpuscles found by Mr. Gulliver in great abundance in the lungs affected with low inflammation (especially chronic), and in gangrene, were ascertained by Dr. Davy to consist chiefly of oleine and margarine. The pus of old abscesses, mature and softened tubercle, fibrinous vegetations on the valves of the heart, and the softened fibrine found in bloodvessels, or on serous surfaces long inflamed, also contain a very large proportion of fatty matter in a solid crystalline, granular, or a liquid form. The following extract, from Mr. Gulliver's notes to Hewson's works, bears on the same point: "In Dr. Benjamin Babington's observations, the specific gravity of the milk-like serum of the blood appeared to be so regularly reduced, as to lead him to believe that the oil exists at the expense of the albumen. There are some facts in favor of the idea that albumen may be converted into oil. The rapid disappearance of the matter of the curd of perfectly fresh salmon, with the subsequent more oily state of this fish, may be owing to a conversion of this kind, according to the conjecture of Sir Humphrey Davy, as I have learned from Dr. Davy. I have observed that the oil in the liver of several fishes increases after death, probably in connection with incipient putrefaction; and Dr. Davy informs me that in the liver of the cod, after it had been kept in a damp place for twenty-five days, he found a small increase of oil with the formation of carbonic acid and ammonia at the same time."—P. 86, *note*.

But there is no chemical fact which throws so much light on fatty degeneration as that of the formation of adipocire from animal flesh when kept moist without access of air. I directed attention to this analogy in the former edition of this work; and Dr. Alison, in his recent essay on "Vital Affinities," (*Trans. of Royal Soc. of Edinburgh*, 1847,) proposes a formula by which the conversion of albumen and water into fat and carbonate of ammonia, may be explained.

[Mr. Rainey, of St. Thomas's Hospital, London, has successfully demonstrated that, in many instances, at least, pulmonary vesicular emphysema is a fatty degeneration of the delicate membrane lining the air-cells. This structure is very thin, almost transparent, and made up chiefly of an irregular interlacement of extremely delicate fibres, and in a healthy state is devoid of any regularly formed corpuscles. If a

thin section of emphysematous lung minutely injected, be examined by transmitted light, it will be found cribriform and perforated. These perforations are well defined, oval or circular, of various sizes, and more or less numerous according to the progress of the disease. In the neighborhood of these foramina, as well as in other parts not cribriform, circular bright spots, varying in size and number, singly or in clusters, are to be seen, and no doubt precede the perforations. This appearance is due to the presence of oil in the tissue of the membrane, or on its surface. In some instances the oil is intimately blended with the substance of the membrane, and only then increases its transparency, producing the appearance of bright circular spots. In others again, less intimately blended, it exists in the form of numerous minute globules. If a small portion of the membrane thus affected be dried, then pressed between two pieces of glass and gently heated, particles of oil will be left in the glass, distinctly visible on examination by the microscope. If it be digested in sulphuric ether, all the spots disappear. It is obvious that, owing to a change produced from some cause or other in the pulmonary membrane, its materials are converted into oil. This condition impairs the mechanical function of the membrane, which, no longer capable of resisting the pressure of the contained air, breaks down.—C.]

The circumstances under which fatty degeneration takes place, much favor the view that I have given, of its being the result of chemical affinities, prevailing as in the examples above cited. As a *general* disorder, or *affecting many organs* at once, it occurs in connection with a feeble circulation and low respiratory powers; and is favored by circumstances which increase the hydrocarbon of the blood, whether they be the habitual indulgence in alcoholic stimulants and the like, or the imperfect removal of biliary matter from the system. An increase of fat, especially of cholesterine, has been observed in the blood of aged persons. Fatty degeneration, affecting a *particular organ* (except in the peculiar case of the liver), is commonly a result of previous disease impairing the freedom of circulation through it, and often leaving a granular or other cacoplastic deposit in its interstices, which, not becoming fully organized, nor receiving the renovating and oxidating influence of the circulating blood, gradually passes into a fatty condition, the lowest in the animal scale, and, in its not possessing azote, approaching to the plurality of vegetable matters. The same changes may result more gradually from the failing circulation and respiration which mark advancing age (§ 48); and will be accelerated in any texture or organ, the structure of which has been injured by previous disease, accident, or disuse.

Under whatever circumstances the fatty transformation occurs, it is obviously a process of degeneration, or degradation to a very low scale of animal or even vegetable life (its occurrence in gangrene is a striking illustration of this point); and both the vital and physical properties of the organs which it invades become lowered and otherwise injured. Thus muscles so degenerated lose much of their contractile power, and if subjected to distension, as in the heart, become dilated, and may be ruptured. The tonic and elastic fibres of arteries also suffer in their spring-like properties, and may yield in pouches or become lacerated,

or, in process of time, petrified. Glands and secreting structures lose much of their secernent activity, and their cells, vessels, and ducts may be clogged or deranged by their fatty contents, especially when these assume the solid form. Parenchymata and interstitial tissues suffer in their properties of softness and cohesion, and in the freedom of their circulation, and become liable to the farther changes of disintegration and calcareous deposition, which is the last kind of degeneration to be noticed.

[Mr. Paget contends[1] that what is ordinarily called "fatty degeneration," is a form of atrophy, and for these reasons: 1. The frequent coincidence of fatty degeneration with emaciation, or diminution of size of the part. 2. The existence of fatty degeneration under circumstances which, in other instances, give rise to simple wasting of the same part. 3. The frequent occurrence of fatty degeneration, with senile atrophy. It is generally agreed that the nucleus is the active agent in the changes which the cell effects. Now, in all Mr. Paget's observations on atrophied parts, he found the nucleus absent or imperfect; and he has so often observed this change in fatty degenerations of the liver, kidneys, and muscles, that he asserts the general fact that, when the accumulation of fat exceeds a very small amount, the nucleus of the cell, or other elementary structure containing it, is pale and indistinct; and when the fat is abundantly collected, it disappears completely. He does not regard the fatty matter, in such cases, in the light of a new deposit, but as one of the products of the spontaneous transformation of the tissues at the end of their proper periods of vigorous existence; so that this condition represents the state of a tissue remaining unrepaired after it has fallen into the ordinary course of degeneration. The formation of butyric acid, during the decomposition of fibrine in the open air, according to Wurtz's observation, and the conversion into adipocire of nearly all the soft tissues of the body, under peculiar circumstances, are arguments in favor of this view. In muscular fibres, the fat-particles are frequently found arranged in the same manner as the proper constituents of the fibrils—sometimes in transverse and sometimes in longitudinal rows. From Rokitansky's observations, it is evident that fat is one of the products of the spontaneous transformation of the higher proteine compounds.—C.]

546. *Calcareous* or *osseous* degeneration approximates the structure which it invades to the character of a mineral, and may be properly designated by the term *petrifaction*. The tissues most liable to the change are those low in the scale of organization, yet constantly moistened by the blood-liquor; such as cartilage, fibro-cartilage, and fibrous tissue, and similar structures resulting from disease. This morbid ossification has been commonly compared to the natural process of the formation of bone; but it resembles that process no farther than in the deposition of solid phosphate of lime in the interstices of the tissue; and where that tissue approaches to bone in its structure, the result may resemble bone, as in the case of ossified cartilages; but in ossified fibrous tissue and membranes, as in arteries and the valves of the heart, the

[1] Lectures, &c. *loc. cit.*

calcareous matter forms plates and masses, which have no affinity to the structure of bone. In fact, the most complete specimens of petrifaction gradually supervene in the deposits of aplastic fibrine in lymphatic glands, in the lungs, on the surface of serous membranes, and on and under the lining membrane of arteries—which, if they escape the processes of fatty degeneration and softening, are ultimately converted into masses or plates of calculous or stony matter, in which there may be little or no animal substance. This process is, therefore, to be viewed as almost entirely chemical, consisting in the concretion and accumulation of a calcareous salt, phosphate of lime, in the debris of animal matter. It is uncertain whether this calcareous matter is the insoluble residue of a successive series of processes of deposition and absorption; or the result of a chemical attraction of degenerating albumen for the phosphate of lime in the adjoining fluids; but the latter seems the more probable notion, and is strengthened by the fact that a similar petrifaction sometimes occurs in loose cartilages in joints, and in detached concretions in veins (phebolites).

The petrifactive process is essentially a slow one; and, as a spontaneous change, occurs most in advanced age; but, like other degenerations, may be induced and accelerated by inflammation, especially of a chronic kind. Thus the cartilages of the ribs and of the air-tubes, and many of the arteries, are generally more or less ossified in old people; they are frequently found in the same state in earlier life, after repeated or prolonged attacks of inflammation in the adjoining parts.

It is scarcely necessary to point out the various modes in which morbid ossification injures the structure and function of parts, by rendering them rigid, inflexible, inextensible, inelastic, and therefore brittle and obstructive. It is this process in particular which stiffens the gait, shortens the breath, and weakens the circulation of advanced age (§ 48), and renders the frame unfit to bear shocks or sudden changes, which it is capable of resisting when possessed of the pliancy, elasticity, and varying powers of earlier life. So a similar change, induced by disease in a particular apparatus, as that of the respiration or circulation, reduces that apparatus to the limited capacity of decrepitude; thus, a young or middle-aged person, with asthmatic breath or crippled circulation from such cause, is so far prematurely old, and encounters more suffering and danger in proportion as his other functions and feelings are active and impressible, and tempt him to trials which the straitened organs are unable to bear. Hence, in connection with ossified bronchial tubes, there may occur occasional attacks of spasmodic asthma and pulmonary congestion; and, incident on ossified valves or arteries, there may supervene painful and dangerous paroxysms of angina—from all of which the equally, but more completely or uniformly, *petrified old man* may remain free, so long as he is kept in a state of vegetable or almost mineral quiescence. These considerations suggest important points of practical application.

Treatment of Degenerations.

547. It may readily be inferred from the preceding remarks, that, if any means are capable of resisting the progress of degeneration of structures, they are those which tend to sustain the vitality of the frame, and to preserve the organic functions in an equally balanced activity. Hygienic influences, such as pure air, regular exercise, and friction of the surface, baths warm or cold, as the system may bear them, nutritious and carefully proportioned food (§§ 60, 219), deserve the first mention among these curative or tardative measures. Of medicinal agents, those generally denominated tonics may be of some little utility; such as preparations of iron, bark, arsenic, and mineral acids; but as, in most cachectic states, the secretions are commonly more or less defective, these medicines are not well borne unless combined with others which obviate this defect, such as alterative aperients and salines; and the combination is presented in a convenient, and, through custom, in an attractive form, in the various chalybeate and saline mineral waters of the most frequented spas. These are the favorite resorts of persons of "worn-out constitution," who are in truth the subjects more or less of degenerative changes of structure, and who find in the regular routine of healthier habits, as well as in the virtues of the mineral waters and baths of these places, a degree of relief and returning strength which they fail to obtain under medicinal treatment at home.

Partial degenerations we have found to be promoted by a disordered state of the circulation of the part, as from congestion or inflammation in a low form; and the treatment must comprise the removal or counteraction of such local disorder, by such gentle means, chiefly topical, as may not compromise the constitutional powers of the subject. There are individual remedies which claim a notice as applicable to peculiar kinds of degeneration.

548. Fibrous and granular degenerations, as they are commonly partial, and result from continued or repeated inflammations, may be in some measure retarded by the less weakening forms of antiphlogistic remedies, such as counter-irritation, local bathing, and friction with stimulant liniments, and the external and internal use of iodine in some of its combinations and alkalies. These means are serviceable in restoring power to muscles injured by rheumatic and other inflammation, which may end in fibrous degeneration. Mercury is generally too weakening as an internal remedy, but in such cases it is sometimes useful externally.

The more peculiar chemical nature of fat, and its special relation to particular organs, the lungs and the liver, suggest to us means which may tend to prevent its accumulation in the system, and substitution for the more animalized textures. The rigid exclusion of all fatty articles of diet, and the sparing use of saccharine matter and fermented liquors, and the selection of lean meats, bread, and succulent vegetables for food, with a fit proportion of salt and other condiments; the promotion of free circulation and respiration, by regular exercise in pure air, with occasional bathing and friction to promote the healthy action of the skin; and the due regulation of the bowels, aided, if necessary, by medicines

which augment the secretion of bile; such are the chief means to be opposed to the adipose cachexia. The tonic remedies recommended in degenerations in general, are also distinctly serviceable here; and I have known several examples of temporary benefit from them, in cases which ultimately proved to include fatty degeneration of the heart. In some instances, the nitric or nitro-muriatic acid has been found beneficial; in others, ammonia; and one is tempted to attach some meaning to the peculiar composition of these agents—as opposed to that of fat—the acids affording oxygen, which may remove a part of the superfluous fat; and both these and ammonia supplying azote, which may contribute to the formation of a more animalized plasma. The disposition which the fatty material has to assume the solid form in these degenerations, suggests an advantage likely to arise from the use of some solvent which may liquefy the fatty concretions; and I know of nothing so likely to possess this quality as the liquid part of cod-liver oil, the utility of which, in removing deposits which abound in fat, will shortly come under our notice.

We know little of means calculated to counteract the calcareous degeneration, farther than those before recommended with the common object of sustaining vital energies, and preventing the nutrition of parts from being perverted by inflammatory or congestive disorder. Hydrochloric acid exerts a remarkably solvent power on salts of lime; in some cases, mollities ossium has been supposed to have arisen from an excessive use of salt, but it is quite uncertain whether such a property would reach to the morbid deposition of phosphate of lime in textures. We have already given some hints on the expediency of limiting the victims of ossification to a restricted sphere of excitement and exertion (§ 546).

SECTION VI.

DEPOSITS IN OR UPON TEXTURES.

548. I apply the term *deposits* to matters which result from an overflow of the nutritive material beyond what is necessary to nourish the textures themselves. The structural lesions, hitherto considered, are alterations of the textures themselves; deposits are new matters added to the textures. The basis of all deposits is the fibrinous matter of the blood; and in the products of inflammation (§§ 450–3) we have described its varieties in relation to its plasticity, or capability of organization. The same division is applicable to deposits which take place independently of inflammation, as results of an overflow of the material of reparatory nutrition, and thus we have *euplastic*, *cacoplastic*, and *aplastic* deposits from perverted nutrition. The history already given of these, as they result from inflammation, will supersede the necessity of much detail now, and it will suffice to advert to the circumstances in which they arise independently of inflammation.

Euplastic Deposits—Cicatrices.

549. When a living part is cut or wounded, the breach may be repaired by three modes: 1. By the growth of the adjoining parts, or walls, of the wound; 2. By the medium of coagulable lymph, which becomes organized, and forms a cicatrix, or bond of union; and 3. By granulations and lymph together. The latter mode being necessarily attended with inflammation, is excluded from notice here; but the other two, as Dr. Macartney has shown, may occur independently of obvious inflammation, and are more perfect without it. To these, however, a certain amount of determination of well-fibrinized blood, which supplies the plastic material, is necessary; for the process of reparation, in all its varieties, is always effected from this source.

The first of these processes occurs chiefly in very small breaches of the surface, as in fine punctures and incisions, and in larger wounds under circumstances which prevent irritation and inflammation. In these instances, there may be no increased redness or swelling, and no obvious lymph effused, but the sides of the wound gradually approximate by an increased production of the textures of the part, until the breach is repaired.[1] In this way, wounds heal spontaneously when covered with a hard clot of blood; or under soothing applications which exclude the air, and at the same time exercise a moderate and equal pressure on the part. "It might be anticipated, that, as this mode of reparation bears so strong a resemblance to the natural formation and development of parts, it is the slowest mode; but this is of little account when compared with its great advantages in being unattended with pain, inflammation, and constitutional sympathy, and leaving behind it the best description of cicatrix."[2] In the case of large burns on the trunk of children, the difference between the two modes of reparation will frequently be that of life and death, for it often happens that the patient sinks under the great constitutional disturbance occasioned by a large suppurating surface, although he has survived the immediate shock of the injury. (*Carpenter's Physiology*, p. 602, Am. Ed.)

550. The other mode of reparation is that long denominated by surgeons *union by the first intention*, in which the sides of a wound heal by the organization of coagulable lymph, or, more rarely, of a clot of blood, which, when complete, forms a cicatrix. The following description of the process is taken from Dr. Carpenter's *Human Physiology*, 3d edition, 1846, p. 600 [Am. ed.]. "This mode of union is ordinarily

[1] The following observation illustrates this process: "I made a small pin-hole in a frog's web; the capillaries that were divided yielded no blood and became obstructed; but the circulation continued, although sluggishly, in those adjoining, which were distant from the puncture the length of six or eight blood-disks. The next day, these vessels were no nearer; but the circulation in them was more active, and the hole was partly filled up; and on the third day it was completely so, yet no moving blood could be seen nearer to it. On the fifth day, the distribution of visible vessels was not altered, but the matter with which the hole was filled had contracted and become opaque, so that the adjoining vessels were drawn nearer together, and the opacity prevented my seeing whether any passed through the cicatrix."—*Gulstonian Lectures Med. Gaz.* July 30, 1841, p. 721.

[2] Dr. Macartney, Treatise on Inflammation, p. 178.

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considered by British surgeons to be the result of an *adhesive inflammation.* In so regarding it, they conceive that they are following out the views of Hunter; but he expressly states that wounds may heal without any pain or constitutional disturbance, the reunion proceeding 'as if nothing had happened;' so that he, in effect, admits that reparation of this kind takes place without inflammation. It is well known that if a slight wound, which is thus healing, be provoked to an increased degree of inflammation, its progress is interrupted, and all the means which the surgeon employs to promote union, are such as tend to prevent the accession of this state. The doctrine that the effusion of lymph for the reparation of the tissues is not to be regarded as necessarily a result of the inflammatory process, is not so novel as its opponents have regarded it, since it has been maintained by many eminent observers, even from the earliest times.[1] The only case in which the occurrence of inflammation can be regarded as salutary, is that in which there is a deficiency of fibrine in the blood, causing a deficient organizability of the lymph," (or, rather, a deficiency of lymph itself.) "It has been seen (§ 438) that the amount of fibrine is rapidly increased by inflammation; and the surgeon well knows that a wound with pale flabby edges, in a depressed state of the system, will not heal until some degree of inflammation has commenced.

"When the liquor sanguinis, known as coagulable lymph, is effused between the two edges of a wound, or upon the surface of a membrane lining a closed sac, the following appears to be the history of its organization. The new matter which is poured out in a fluid state, and which seems to have been subjected to the peculiar influence of the colorless corpuscles that rapidly collect in large numbers at the injured spot, undergoes a coagulation resembling that of the blood; the serum, being set free by the concretion of the fibrine, is absorbed; and the fibrinous coagulum speedily attains an almost membranous density. If examined with a microscope at the commencement of the process of organization, it is seen to contain a large number of cells, which sometimes closely resemble the colorless corpuscles of the blood, and in other instances (especially where there has been active inflammation), present greater similarity to pus-corpuscles; these cells, which are known as exudation corpuscles, probably originate from the granules set free from the colorless corpuscles of the circulating blood, and exuded with the liquor sanguinis. In a short time, these corpuscles present the appearance of regular cells disposed in layers, and adhering together by an intermediate unorganized substance, bearing, in fact, a strong resemblance to the cells of tessellated epithelium. Some hours later, the mass exhibits an evidently fibrous character; and this is due to the farther elaboration of the plastic material by the cells just mentioned. Between these

[1] Although I admit that inflammation, in its pronounced form, is not essential to this reparation, yet there seems to be a close approximation to this process. When a frog's web is cut or pricked, the vessels adjoining the wound are immediately obstructed by coagulated blood; but in a few seconds, those adjoining them become enlarged, and receive an increased current, and it is this determination of blood towards vessels which are obstructed, which causes an increased transudation of the plasma of the blood (§ 419). If this do not amount to inflammation, it differs from it only in degree.

fibres a considerable amount of unorganized substance (§ 523) yet remains, and they may be readily separated or torn in any direction. A vascular rete next makes its appearance in connection with the vessels of the subjacent surface; the first appearance of this network is in the form of transparent arborescent streaks, which push out extensions on all sides; these encounter one another, and form a complete series of capillary reticulations, the distribution of which very nearly resembles that which has been seen in the villi of the intestines. From the observations of Mr. Travers, it appears that isolated globules enter these capillary tubes, and perform an oscillatory motion in them for some hours before any series of them passes into it; so that we cannot regard the new channel as burrowed out by a string or file of red corpuscles, pushed out by *vis à tergo* from the nearest capillary, as some have maintained.[1] And he has farther established two important facts in the history of the reparation of tissues, which correspond with the observation just cited: 1, that the liquor sanguinis, first effused, is not sufficiently organizable to become an entirely new and permanent tissue, although adequate to afford nutrition to the old, and to form a new tissue of temporary character; and 2, that the generation of new tissue is preceded by the collection of a large number of white corpuscles in a nearly stationary condition in the bloodvessels immediately subjacent, and by the appearance of a large number of similar cells in the newly forming tissue, the two together constituting what Mr. T. has aptly called the lymph-bed of organization. This process appears to be conformable in all essential particulars with that which has been observed in the development of the toes of the larva of the waternewt and similar growths."

Under some circumstances, the fibrine of coagulable blood has been found to become vascular, and more or less organized. Thus clots of blood in the bloodvessels have been injected, and those effused in the brain in apoplexy have been found pervaded with vessels (Cruveilhier); but the coloring matter does not appear to assist in the process; in fact, blood coagulated in or upon a wound generally comes off in a scab as soon as the wound is healed. In other instances, the presence of coloring matter seems to retard or degrade rather than assist the plastic process (§ 454).

551. The *remedial measures* by which the euplastic process is promoted in cases of injury, are treated of in surgical works. Their object is to promote such an amount of determination of blood (whether this be called inflammation or not), and such a plastic condition of the blood. as shall contribute to the effusion of a sufficient amount of healthy organizable lymph. Where inflammation rises too high, it causes too much effusion of the plasma, which degenerates into aplastic pus-globules, and it destroys the adjoining textures; here it must be repressed

[1] There is nothing in Mr. Travers's observations which oppose the inference, which is drawn from numerous other facts, that the motion of the particles in these new channels is derived from the adjoining capillary vessels. The oscillatory movements are those of the pulsation of the heart, and are seen in many instances on the arterial side of obstructed capillaries. No current of blood, or file of red corpuscles, can pass until there is also a communication with the veins.—See note, p. 262.

by antiphlogistic measures. If the inflammation is too low (§ 477), or the determination of blood is wanting, then the plasma will be defective in quantity or organizability, and the wound will not heal, or will heal imperfectly. Here stimulant applications may be useful. Where the blood is too abundant in fibrine, the plasma thrown out will be too copious to admit of organization, and will consequently become purulent, and therefore aplastic. Here, bloodletting or evacuants, and low diet for a time, may be serviceable. Where the blood is deficient in fibrine, the wound will be flabby and the discharge ichorous or sanious, from want of the proper plasma; here, nourishing diet, tonics, and even stimulants, general and local, may be useful. The efficacy of a pure healthy atmosphere, which contributes to the due oxygenation of the blood, is sometimes very remarkable; and the salutary effect of nitric acid, used both externally and internally, is perhaps to be ascribed to the same principle (§ 216). Where the wound exhibits congestion more than determination of blood, and the plasma is organized into loose spongy or fungous masses, projecting from the wound, astringent and stimulant applications are beneficial.

Cacoplastic and Aplastic Deposits.

553. Under various circumstances which have been alluded to in the preceding remarks, wounds or ulcers may be repaired by lymph which is *cacoplastic*, or defective in organizability; and the cicatrix resulting from such imperfect reparation is lower in the scale of vitality than the texture in which it is produced. Thus in the skin, a tough, hard, opaque white fibro-cellular structure, constitutes the cicatrix; the seams formed on the healing of scrofulous sores sometimes exhibit this character; the blood not supplying a good plastic material. Or, sometimes, the cause of the degraded organization seems to be in the nature of the wound, or in a modification of the vessels of the part, or of their exudation, as in the scars which result from burns and scalds, and from some poisoned wounds. In these cases, the cicatrix is dense and thick, and tends farther to contraction, which causes a puckering of the parts, and sometimes great distortion of the integuments. Similar deposits have been noticed to result from chronic and scrofulous inflammation of internal parts (§§ 479, 485), and from congestion (§ 311), and to constitute the material of dense fibro-cellular and fibro-cartilaginous formations on and under serous and in cellular membranes; the indurated interstitial structure which characterizes cirrhosis,[1] and granular degeneration of the liver and kidneys, and old cicatrices and consolidations very commonly met with in the lungs. The opaque, tough thickening of the valves of the heart, often attended with corrugation, contraction, and rupture, and

[1] The term cirrhosis (from the obsolete Greek word κιῤῥος, *yellow*) was first applied by Laennec to the contractile disease of the liver; because the interstitial deposit which causes the contraction is often yellow from being stained with bile. The term is obviously inapplicable to contractile deposits in the lung and other parts; to which, nevertheless, the name has been applied. The epithets granular or contractile deposit are respectively more suitable to the forms in which this cacoplastic product manifests itself.

the similar change in the coats of arteries, appear to belong to the same class of deposits.

554. The structure of these deposits deserves to be more fully investigated. They appear to possess some organization, being composed of irregular cells and fibres, with more or less granular or amorphous solid matter to complete their substance (§ 424). They, however, exhibit various degrees of organization, some being vascular, and some not; but they are all inferior to the structure with which they are connected, and to the euplastic deposits above described. Although rarely occurring in great abundance in an organ or structure, except from some hyperæmia of that part, yet, in a small extent, cacoplastic deposits are to be met with in most subjects at all advanced in life, and more particularly those who have long suffered from ill health. The opaque thickening of the membranes investing the liver, spleen, lungs, heart, and brain, often arborescent from its accompanying the course of the blood-vessels—the coarser, and less regular granular appearance exhibited in parts of the liver and kidneys, especially at their most depending portions, the granules commonly adhering to the capsule of the viscus, when it is torn off—the partial consolidations of the lungs, particularly near their apex—the opaque patches in the lining membrane of the heart and arteries—are all specimens of the result of cacoplastic deposits which age or disease has produced; and the more the nutrient function has been degraded in the individual, the more abundant will be the specimens of this cacoplastic deposit. But generally this deposit takes place more abundantly in one particular organ, in consequence of disease predisposing it to suffer (§§ 31, 2). Thus, if a person, from habits of intemperance, or other cause, has injured the function or structure of the liver or kidneys, in the lapse of time, as the nutritive function begins to fail from age and debility, the injured organ is the first to suffer, and becomes the subject of cirrhosis, or granular degeneration; and this may destroy life by arresting circulation and excretion, &c. (§§ 170, 311), before other organs are much affected; hence dropsy, jaundice, albuminuria, &c.

555. But there is another more general form of cacoplastic deposit, which takes place when textural nutrition is degraded still farther than in the preceding examples; this is in *semitransparent, miliary, gray, and tough yellow forms of tubercle.* Instead of (with Laennec) classing tubercle under the vague term of "accidental productions," or (with Carswell) as a "secretion *sui generis*," I have for many years referred tubercle to a degraded condition of the nutritive material, from which old textures are renewed, and new ones formed; and have held that it differs from fibrine or coagulable lymph, not in *kind*, but in *degree*, of vitality and capacity of organization.[1] These views have received almost demonstrative confirmation in the microscopic researches of Mr. Gulliver and others, which have detected in tubercle the materials of lymph, but in a degenerated and confused state; the cells being few,

[1] A somewhat similar opinion, but less definitely expressed, has been entertained by Dr. Alison, and formerly by M. Andral; but these pathologists seem originally to have regarded tubercle chiefly as the product of a modified inflammation.

irregular, shrivelled, with imperfect nuclei, and incapable of farther development; no fibres being perceptible, and the main substance being composed of granular or amorphous matter.[1] [The microscopical examination of tubercle presents the following characters: 1. An amorphous, transparent stroma, resembling, in chemical reaction, coagulated fibrine. 2. Minute unorganized granules, varying in diameter from the 800th to the 1200th part of an inch, which are not unlike the albuminous granules of the blood. They do not invariably exhibit the same reaction with chemical agents, which would appear to be owing to the period at which they were deposited. 3. Cytoblasts, or imperfectly formed cells, varying in size between the 200th and 500th of a line. According to Lebert,[2] Drs. Hughes Bennett, and Leeper,[3] they never contain nuclei; whilst according to Gulliver and Vogel, they are often nucleated. Dr. P. Blakiston says that "it is certain that a faint appearance of a cell-wall may sometimes be seen around these corpuscles; at other times, there are traces of such cells without any nuclei."[4] In recent firm tubercle, the amorphous stroma and cytoblasts predominate, the latter being in clusters. In soft tubercles, they are generally farther apart, and less numerous, whilst the granules are greatly increased.—C.] Every gradation may be found between euplastic and aplastic deposits;

[1] "Corpuscles more or less globular or oval are seen in tubercles; but the granular matter preponderates as the tubercular mass increases. Cells may be recognized in the miliary tubercles; but, as they increase in size, the well-marked and complete cells disappear. Tubercles appear to differ essentially from the plastic exudations, inasmuch as the cells of the latter not only grow into a higher organization, but increase in number towards the centre; in other words, plastic matter has an inherent power of multiplying and evolving organic germs. But tubercle has no such power; for it would appear that its primitive cells can only retrograde and degenerate." (*Gulliver's Appendix to Gerber's Anatomy*, p. 87.)—"If a tubercle, or even the tissue of the lung near it, be slightly compressed between two slips of glass with a drop of water, it will crumble down and break to pieces, the fluid being at the same time quite white or milky. This white appearance is attributable to a great number of minute objects, the assemblage of which constitutes the substance of the tubercle. They consist for the most part of molecules, granules, and granulated corpuscles of various sizes, of aggregated granules without any tunic, and of collapsed tunics, without any granules. These objects are mingled with a great many shapeless flakes and filaments, which are no doubt fragments of the membrane of the air-cells, and of the minute bloodvessels, which, when involved in a tubercle, become so extremely brittle, that they must necessarily form a considerable proportion of the objects occupying the field of the microscope. The granulated corpuscles of a tubercle are sometimes very large (1-800th or 1-1000th of an inch); and the molecules and granules, which are very conspicuous, may frequently be seen on the point of escaping from them. . . . The semitransparent forms of tubercle and tubercular infiltrations owe their peculiarity to a great relative amount of granulated vesicles (*cells*, Gulliver); whereas the opaque white forms of tubercle are attributable to great numbers of isolated granules."—*Mr. Addison's Experimental and Practical researches, &c., Trans. Provincial Med. and Surg. Association*, 1843, pp. 287–8.

These quotations supply microscopic evidence in favor of views regarding the nature of tubercle, which I have long held and taught, and to which I was led by an attentive examination of the common characters and changes of lymph, pus, and tubercle. A brief notice of these views may be found in the four editions of my little work on the *Pathology and Diagnosis of Diseases of the Chest*; in my *Lectures on Diseases of the Chest*, published in the *Medical Gazette*, of 1837–8; and in the *Library of Practical Medicine*, vol. [ii. 1842; and *Williams and Clymer on Diseases of the Respiratory Organs*, p. 337, Phila., 1844]. All these works were published long before any of the above microscopical examinations were made.

[2] Physiologie Pathologique, &c., Paris, 1845.

[3] Report on Tubercle, Dublin Quarterly Journal of Medical Science, No. VII.

[4] Practical Observations on Certain Diseases of the Chest, &c. Phil. reprinted 1848.

the cells and fibres, which are the representatives of organization, diminishing in number and completeness, and the material becoming more granular, amorphous, or abounding in fat-globules, in proportion as the deposit is degraded, until, in opaque, crude, or yellow tubercle, it is altogether aplastic, consisting of a mere aggregation of granules and fat-globules, with mere traces of the remains of cells.

I consider that the more solid forms of tubercle are entitled to a place among cacoplastic deposits; because, although destitute of vascularity, they seem to possess a kind of structure like that of the lower kinds of fibro-cartilage and granular deposit. Their affinity with granular degeneration (§ 544) is shown by their commonly occurring in the same subjects, and by their frequently exhibiting the same tendency to contraction. In a very large majority of cases of chronic granular disease of the kidneys or liver, there are found more or less traces of tubercle in the lungs, its chief seat; and in a very few instances of chronic phthisis have I failed to find some degree of granular disease in the liver or kidneys. In acute phthisis and acute granular disease, local causes accelerate the degenerative change to a destructive extent in one organ, before there is time for others to become affected.

556. Let us now trace the history of cacoplastic deposits in a few examples. The dense false membranes on the surface of serous membranes, may be often seen surrounded by a radiated wrinkling or puckering of the adjoining parts, indicating that the new deposit has shrunk in size. A similar contraction is noticed in the deposits on and under the lining membrane of the heart and its valves, and causes a serious disturbance of their mechanism. The contraction of the chest, in some cases of pleurisy, is in part dependent on the same property of cacoplastic deposits. This general tendency of false membranes to contract, was long since pointed out by Dr. Hodgkin and Laennec; and the fact has been subsequently applied by Dr. Carswell to explain the contraction of the liver in cirrhosis, which he considers to depend on a deposit in the intravascular filamentous texture prolonged from the capsule of Glisson. I do not consider that the contractile deposit in cirrhosis is exclusively confined to any texture, but is exuded from the distended bloodvessels themselves. False membranes, which exhibit the same contractile property, are sometimes found on the free surface of serous membranes, and especially along the course of the vessels (veins as well as arteries); and on the liver and lung, depressions, from atrophy of the substance of the organ, are sometimes seen under these deposits. There can be little doubt that these deposits are a fibrinous material exuded from the vessels in certain pathological states (congestion, chronic inflammation, and malnutrition), and form a dense structure of low vitality, which, by its subsequent contraction, tends to constrict and compress the subjacent parts, and more or less to interfere with the passage of blood through them, and consequently with their secretion and nutrition. The same tendency is shown in the higher (less aplastic) forms of tuberculous disease. Miliary or granular tubercles in the lungs, when in considerable numbers, and not soon softening, cause a contraction of the lung, chiefly at the upper part, and a corresponding collapse in the upper part of the chest. I have met with

many cases, in which a sinking in of the infraclavian region took place before any symptoms of softening or excavation had occurred; indeed, it is a very common sign of tubercles which long remain stationary. The still greater amount of collapse, in the advanced stages of tuberculous lesions, although partly dependent on other causes, is also in some degree connected with the contraction of cacoplastic deposits in the lungs and pleura. In the peritoneum, agglutinated tubercles often cause considerable contraction; and I have seen the omentum thus puckered up into a knotty mass.

The microscopic examination of cacoplastic deposits at different periods gives much explanation of these contractile changes. When recent, it consists of fibres with a great amount of granular matter, with and without cells, and more or less amorphous material. When examined older, and after having contracted, it is much more tough, and is found to be more distinctly fibrous, much of granular and amorphous matter having disappeared. Old contractile adhesions and cicatrices are still more dense, and are found to consist almost entirely of closely interwoven fibres, differing from those of fibro-cartilaginous tissues only in being less regular and distinct. It appears, therefore, that it is by the partial absorption of the granular and amorphous portion of the deposit, and by the closer approximation of the fibres or more organized constituent, that the condensation takes place. Hence it is that the structure so contracted is less liable to the farther degeneration to which cacoplastic deposits commonly tend. Certain it is that, of different portions of cacoplastic deposit in the lungs and elsewhere, those that are contracted remain unchanged, whilst others pass into the aplastic state of opaque and softened tubercle. This contractile process seems, therefore, to raise the deposit to a higher standard, in which, although below them, it is tolerated by the adjoining textures. But this very change may seriously injure the textures of organs, by contracting and compressing their vessels, and interfering with their nutrition and other functions; and in this respect it may be classed with the highest, or most animalized variety of degeneration, the fibrous, which has already been described (§ 543). This is the chief mode in which contractile diseases of the liver and kidneys gradually infringe on the circulation and secretion of these organs, and thus may eventually prove fatal (§§ 249, 375). The contraction which takes place near the summits and roots of the lungs, in the more limited and therefore chronic forms of pulmonary tuberculous disease, often lays the foundation of emphysema of the lungs and habitual asthma. I have notes of a large number of cases illustrative of this fact; but such details belong to special pathology, and are reserved for another work. Similar contraction occurring in the deposit under mucous membranes of the alimentary and urinary passages, constitute strictures, which occasion much distress and serious disorder.

557. Having adverted to the less degraded or degenerating form of cacoplastic deposits, we have now to notice those of a lower character, which tend to become aplastic. These include the commoner forms of tubercle. In the granular, miliary, gray, or drab-colored tubercles of serous membranes and parenchymata, we find a dense homogeneous

solid, closely resembling some of the other cacoplastic deposits which have just been described. Their resemblance, and even identity, may often be well traced in chronic or subacute arachnitis, peritonitis, and pleuritis, in which portions of the affected membrane are covered with diffused patches of semiopaque deposit which no one would hesitate to call false membrane; whilst in other parts, the same deposit occurring in separate granules, exhibits all the characters of granular or miliary tubercle. But how comes it (it may be asked) to assume the granular form? In answer to this question, I may refer to the observations made on the products of inflammation (§ 449), where it was pointed out, that the effusion of lymph on an inflamed membrane is at first granular, and would continue to be so, if it were not drawn or spread into threads or films by the friction or pressure of the surfaces where it is poured out; and several examples were cited, in which, from the absence of such friction or pressure, the granular appearance is preserved even in acute inflammation. In scrofulous and chronic inflammation, in which the matter effused is from the first less ductile and more consistent, the granular condition more generally prevails and remains even in spite of pressure and friction; and it is generally admitted that the product of chronic inflammation of the peritoneum and arachnoid is always more or less granular. Even in acute inflammation of tuberculous subjects, recent lymph is commonly studded with opaque granules, which subsequently would assume the character of tubercles.

But tubercles do not always result from inflammation. In many cases, they are found disseminated in so many textures, after few or no symptoms of inflammation, that it is impossible to regard them otherwise than as the result of modified textural nutrition. The cell-germs by which the material of textures is renewed, are imperfect at particular points; a granular or amorphous matter is deposited from the plasma, and concretes without fibres or regular cells being developed; at this point a granulation appears, and gradually hardens. Where a granule has once been formed, it becomes a nucleus for the concretion of more; a new habit or mode of nourishment is established at the spot; or, to speak less figuratively, cacoplastic matter (if present in the blood plasma) concretes around it by a process similar to that by which fat attracts fat, or bone osseous matter; perhaps the process is not wholly unlike that of crystallization. But however it happens, the result is, that the granular tubercle grows, and may attain the size of a millet-seed, hempseed, or even a small cherry-stone; or, being subjected to pressure, may slightly spread or flatten into various shapes.

The microscopic character of these miliary or granular tubercles is the complete predominance of minute and often irregular granules, and the comparative absence of fibres and cells, of which mere traces are seen, at least in the older specimens. The granules are aggregated together by an amorphous material, the solidity of which gives hardness and some translucency to the mass; for acetic acid or alkalies, which dissolve this cement, loosen the granules and render them distinct. The chemical nature of granular tubercle is albuminous, with some gelatine and a little fat, the latter in very minute proportion, and occupying the centre of some granules; and the gelatine being probably the

amorphous cement just noticed. In all these characters, we find a close analogy to the granular degeneration of textures (§ 544), and of which doubtless these deposits are a kind of exaggeration.

558. Tubercles rarely grow much or last long without exhibiting another change in their appearance. They lose their semitransparency, and become of an opaque or dead pale yellow hue, like the color of raw potato or parsnip. This is the transformation to crude yellow tubercle first described by Laennec. This change is the result of a farther degradation or degeneration of the deposit. The few fibres and cells which are to be detected in gray tubercle become indistinct, the interstitial hyaline or amorphous solid diminishes, and oil-globules appear in its stead, and the mass becomes less coherent and more granular, and therefore quite *aplastic*. Generally, the change begins in the centre of the mass; apparently because, being devoid of vessels, the centre is farther removed from the vivifying influence of the blood. In a similar manner, the cornea and other nonvascular textures become opaque from deficient supply of sustaining nutriment in the plasma, and may wholly lose their organization (§ 269). A parallel degradation is observed in the degeneration of fibrous and cellular tissues into granular matter, recently pointed out as the result of malnutrition (§ 544). But not only will deficient supply of plasma promote the transformation of tubercle from gray to opaque; but an undue flow or accumulation of blood, as by congestion or inflammation in the neighborhood, will also accelerate this change, just as they hasten the disintegration of lymph and of compressed textures, the plastic into the aplastic, by the increased warmth and afflux of fluids exalting chemical affinities in a material which has no vital power of resistance by which living tissues maintain their integrity.

559. But tubercle is frequently deposited at first in this yellow, opaque state, this circumstance being a mark of the still more degraded condition of the nutritive function; and the more extensive forms of tuberculous disease commonly abound in this aplastic matter. Thus in rapid phthisis, whether resulting from acute inflammation in a scrofulous subject, or from the excessive prevalence of a scrofulous diathesis (cacoplastic matter in the blood), yellow tubercle commonly forms a large portion of the deposit; and it is in these cases that its resemblance to, and connection with, coagulable lymph, may be best seen.[1] Yellow tubercle is rarely so hard or so tough as the gray or semitransparent kind; and in the cases of rapid deposit just mentioned, it is often much softer and more friable. Now, this is the commencement of a change to which the lowest forms of tubercle tend—that of *maturation* and *softening* into a cheesy substance. The conversion of the gray into opaque tubercle, and the farther softening of this, seem to be the converse of the contractile process to which the higher class of cacoplastic deposit tend; in that (the contractile process) the deposit becomes more dense and organized; in this (opaque change and softening) the deposit

[1] The affinity between lymph and tubercle was recognized by older writers; and after it had been kept out of view by the too exclusive opinions of Bayle and Laennec, it was again pointed out by Dr. Alison.—*Trans. of Medico-Chirurg. Soc. of Edin.* vols. i. and iii.

becomes less dense, and loses the little trace of structure which it possessed; it degenerates into an amorphous, granular mass; and being lifeless, it is no longer nourished; but its granules lose their cohesion, and become disintegrated by the chemical action of the adjoining fluids.[1] Mr. Gulliver and others have observed a remarkable increase of fat-globules in softened tubercle. In fact, from the time that tubercle assumes the opaque form, these oil-globules appear to increase; until it is either softened and eliminated, or undergoes the petrifactive change to be described hereafter.

The formation of fatty particles in old pus (§ 460), in atheroma of arteries, and in chronic inflammatory deposits and gangrene of the lungs, seems to show that fat is sometimes a debris of animal matter, as in the conversion of flesh into adipocire (§ 543). The lenticular corpuscles concentrically striated, supposed by Gruby to be characteristic of softened tubercle, Mr. Gulliver has found, in various textures, unconnected with tubercle or any other disease. The detection, by Dr. Davy, of oleine and margarine in opaque exudation corpuscles in the lungs (§ 543), and the observation, by myself and others, of numerous fat-globules in deposits in the kidneys, spleen, and vegetations on the valves of the heart—show a tendency to the production of fat in all degenerated plasmata. In many instances, the fatty matter appears in a solid form, either crystallized or in granules, rather than as distinct oil-globules; and this fact suggests that a change in kind, as well as an excess in quantity of fat in the deposits, has occurred, and probably prevents its absorption. These facts, which have before been noticed under the head of fatty degeneration (§ 545), prove that morbid deposits are amenable to the law of the fatty or hydrocarbonaceous transformation, in common with natural structures; and they are more liable to this sinking in the scale of organic matters, in consequence of their low vitality, and from their extravascular position placing them beyond the reach of the decarbonizing influence of the circulating blood. As the change seems to be in a great measure spontaneous, and promoted by moderate moisture, it increases with the age of the tubercle, within certain limits, beyond which the mineral transformation, petrifaction (also chemical), ensues. But the softening, if early, depends on a decomposition which is more destructive, and this, by generating matter offensive to the adjoining textures, and to the whole frame, may cause local and constitutional irritation, so strongly marked during the extensive and rapid softening of tuberculous deposits.

[Rokitansky thus describes the softening of tubercle: "After the

[1] Dr. Elliotson, I think, first suggested that the softening of tubercles is due to a spontaneous chemical change. I also consider the change to be chemical; but to be much promoted by the action of fluids from adjoining parts. So long as tubercles are kept free from superfluous moisture, they manifest little disposition to change; but an afflux of fluids around them hastens their maturation and softening. This effect may be rudely illustrated by the action of water or serum on coagulated albumen. When nearly dry, it is tough and semitransparent; but when well moistened, it becomes opaque, soft, and friable. The softening and disintegration of clots of fibrine by warmth and moisture give another illustration of the same change. [Lebert believes that the softening of tubercle depends upon the liquefaction of the transparent hyaline mass, in which the granular matter is imbedded.—*Physiologie Pathologique, &c.*, Paris, 1845.—C.]

tubercle has existed for some time in the state of crudity, it becomes, as it were, loosened in its textures, and usually increases in volume; it breaks up on slight pressure, and becomes more moist; then changes into a yellowish, dissolving, caseine-like, fatty and viscid matter, and finally breaks up into a thin, whey-like, acid fluid, in which flocks and shreds—the remains of the imperfectly disintegrated tubercle—are observed swimming. This is tubercular pus. . . .

"The softening consists in the solution and disintegration of the solid groundwork of the tubercle, into a fluid containing an abundance of the minutest molecules. This change is followed by a separation and isolation of the above-named histological elements of tubercle, which undergo more or less marked alterations by their immersion in the fluid; the cells become distended, corroded, and are finally dissolved; the nuclei shrivel, and assume irregular forms, becoming angular and indented. Finally, in softened tubercle we meet with free fat.

"The dissolved tubercle consists—

"*a.* Of a fluid with minute molecules.

"*b.* Of altered nuclei and cells isolated in the manner we have described.

"*c.* Of free fat in the form of elementary granules, and distinct globules of a larger size.

"2. The other metamorphosis of this form of tubercle is cretefaction. It occurs as a secondary change, never attacking tubercle in its original form, but confining itself to the dissolving or dissolved tubercular blastema.

"In softening or softened tubercle, the calcareous salts and fat occur in the form of free, distinct, or aggregated elementary molecules, or in granular cells; the fat also not unfrequently occurs in the form of large drops or of crystals of cholesterine. In this process, the softened tubercular mass gradually thickens into a moist, fatty, viscid kind of plaster, and, finally, diminishing in volume, is converted into a mortar-like concretion."—(*Handbuch der pathologischen Anatomie*, p. 398, from *British and Foreign Medico-Chirurgical Review*, vol. i. p. 173.)—C.]

560. But in these different changes in tuberculous matter, as well as in the original deposition of this matter, the adjacent living parts have a considerable share. A miliary tubercle, from its first formation, may become a cause of irritation and obstruction to the contiguous textures. The amount of this irritation and obstruction will depend on the natural or present vascularity and excitability of the part, its function, and the situation and size of the tuberculous deposit. Thus, in vascular textures, especially parenchymata, there is more tendency to mischief and change than in serous membranes. Where the irritation is very slight, it may merely cause so much determination of blood as to promote the growth of the gray tubercle. Where it is more, it may cause the conversion of gray into yellow tubercle, its farther increase in this form, and its softening. If the irritation be still greater, inflammation is excited around the tubercle; and its marks are often seen after death in the areolar of vascular redness; and the products of this inflammation (pus, lymph, mucus, serum, &c.) may also hasten the softening of the tubercle, their mixture together, and their evacuation by ulceration into

adjoining open surfaces. Or, the product of inflammation being more solid and plastic, consolidations, or false membranes, are formed around the tubercle, and its irritating influence may be thus circumscribed. Thus, although we have just mentioned that the opacity, maturation, and softening of tubercle depend essentially on a farther degeneration and loss of structure, yet these changes are much promoted by the afflux of blood to the neighboring parts.

561. In the absence of any of the circumstances just mentioned, which tend to promote the increase or farther change of tubercle, we find that it may remain harmless for months, and even for years; but then it often exhibits farther transformations which may be considered spontaneous or chemical. This remark does not apply to the change of the less cacoplastic deposits by contraction, which has been already noticed as an elevation of the deposit to the condition of a fibrous tissue nourished and preserved as a living part. In the lungs, the consolidations may remain long without any contraction, but they become deeply blackened by an accumulation of the peculiar black matter of the lung. Yellow and softened tubercle, if not evacuated, in time becomes replaced by a plastery, or putty-like matter, composed chiefly of phosphate of lime and often containing solid concretions, consisting entirely of that earthy matter.—[These cretaceous or puttaceous remains, are generally found encysted.—C.] This petrifactive change reminds us of what takes place in the cacoplastic deposits in the coats of arteries and on serous membranes (§§ 544, 553), constituting what is erroneously called ossification; and this completes the fourth and last parallel with the degenerations which kindred textures undergo from the influence of age or disease; the osseous or mineral transformation. The calcareous conversion of tubercle can be explained only on the supposition that the organic matter is absorbed, and the earthy salt is deposited in its place. This is exactly like what takes place in true petrifaction of organized bodies, the silica or calcareous substance being substituted, molecule for molecule; so that, when all is converted into stone, the shape of the organized body is retained. And we farther learn from this that the animal matter of tubercles may be absorbed. The occasional absorption of tuberculous matter is farther proved by its accumulation in the bronchial and mesenteric glands, which sometimes contain it when the lungs and the intestines present little more than traces of it, such as cicatrices, with some cretaceous matter in them. In the bronchial glands, too, the tubercle very commonly exhibits the petrifactive change, and the concretions so commonly found in these glands may generally be ascribed to this cause.

562. The circumstances which degrade the material of nutrition, and lead to the deposition of cacoplastic and aplastic matter, may be either local or general. Of the local causes, congestion, and the lowest and more chronic forms of inflammation have been mentioned as capable of determining cacoplastic deposits; but even in these cases it is probable that the general cause also more or less operates—that is, a degraded state of the plasma of the blood. Congestions and chronic inflammations certainly cause cacoplastic effusions; but, then, such congestions and chronic inflammations do not easily occur in healthy subjects; and

the want of health may imply that the plasma of the blood is bad in addition to the local cause. But practically, it is of great importance to keep in view the local as well as the general cause, for the former is often more tractable than the other, and it is by guarding against it that slighter degrees of the general cause (diseased plasma) may be prevented from doing mischief. But the general cause, when present in great degree, leads to cacoplastic and aplastic deposits, as modifications of ordinary textural nutrition, independently of inflammation or even congestion. This general cause thus prevailing, constitutes the chief element of the scrofulous diathesis, or tuberculous cachexia; and we have before mentioned that a defect of the red particles and an excess of fibrine in the blood constitute its most remarkable feature (§§ 185, 211). In this condition of the blood there is an increased disposition to deposit, and often an abundance of the fibrinous or nutritive material, but an imperfect vitality or organizability of this material, so that when deposited, instead of being assimilated to the textures, it forms the degenerated structures or mere granular or amorphous deposits, which we have been describing. But with this condition of the blood, these deposits must be greatly promoted by all varieties of hyperæmia, and prevail most in organs which receive the largest amount of blood. Hence, the peculiarly pernicious effect of inflammation of internal organs, especially the lungs, in scrofulous subjects. Even acute inflammation may be unequal to raise the nutritive material to a plastic standard at which it may be organized or absorbed, or to mature it to the process of complete suppuration by which it may be speedily excreted; but the matter thrown out is cacoplastic or curdy lymph, remarkable for its opacity and want of cohesion, or a caseous kind of pus, inorganizable, inert, irremovable by absorption, and permanently obstructing or compressing the structures in which it accumulates, until it gradually excites an irregular destructive suppuration or ulceration, forming vomica, or imperfect abscesses, pervading the structures, and without walls capable of healing; whilst under the depressing and irritating influence of the morbid matter decaying and becoming decomposed, the body wastes with hectic fever, night-sweats, and colliquative diarrhœa. So likewise fevers, by causing congestions in organs, lead to the production of a *crop* of these deposits, from which tuberculous disease takes its origin.

[No point of pathology has been the subject of more violent disputation than the question, whether or not tubercle is the result of an inflammatory action. Laennec opposed the inflammatory theory. Carswell has advocated warmly and ingeniously the same view. Dr. Baron, of Gloucester, thought that tubercles were not the product of any species of inflammation. Broussais was the ardent advocate of the inflammatory origin of tubercle. Andral thinks that, where predisposition exists, any slight local congestion of blood will give occasion to its production. Dr. Alison, of Edinburgh, is probably the most elaborate supporter of this doctrine, from his own observations, and from the experiments of others. Hughes Bennett, Evans, Blakiston, and others, maintain the positive side at the present time; whilst Nicollucci, Lebert, Gellerstedt, and Rainey, oppose it. The true state of the question is, to our mind, so justly stated by Dr. Leeper, that we give it in his own words: "For

ourselves," he observes, "we have long thought that authors have been hunting after a shadow, in endeavoring to settle the point in question. Believing, as we do, that tubercular matter exists in the blood of the scrofulous, in the form of a *tubercular plasma*, we are of opinion that it may be exuded in that condition of the capillaries in which, under other circumstances, fibrine would be effused. If the latter state be called inflammation, and it is only an excited state of nutrition—then, in the case of tubercular effusion, the inflammation is a peculiar and anormal one, and the product is also anormal."[1] Dr. H. Bennett holds nearly the same language.—C.]

563. The lungs and bronchial glands are by far the most common seat of tubercles; when found elsewhere, tubercles commonly abound more, and are more advanced in these parts. The situation of the prevalence of tuberculous disease varies also with the age of the subject. Thus, M. Papavoine found yellow tubercle in children to occur especially in the cervical and mesenteric glands; next, in the spleen, pleura, liver, and small intestines; less frequently in the large intestines and peritoneum; and more rarely in other parts. In 350 consumptive (chiefly adult) cases examined by M. Louis, tubercles were found in the small intestines in one-third of the whole; in the mesenteric glands, in one-fourth; in the large intestines, in a ninth; in the cervical glands, in a tenth: in the lumbar glands, in a twelfth; in the spleen, in a fourteenth of all the cases; and in other parts, in smaller proportions. [In 100 young subjects, Lombard found the bronchial glands affected in 87, the lungs in 73, the mesenteric glands in 31, and the spleen in 25. In 100 adults, the lungs not included, he found the intestines affected in 26, the mesenteric glands in 19, the bronchial glands in 9, and the spleen in 6. The relative frequency of tuberculization of the bronchial glands in the child and adult, is as 87 to 9, or $9\frac{3}{4}$ times more frequent in the former. Of three hundred and twelve tuberculous children, Rilliet and Barthez found the lungs free from tubercles in one-sixth only. According to MM. Rilliet and Barthez, we find tubercular matter in children more frequently in the lung than in any other organ; next, the bronchial glands; afterwards, but at some distance, the mesenteric glands and small intestines. After these organs, the pleura and spleen are most liable; and then the peritoneum, the liver, the large intestine, the meninges, the kidneys, the heart, stomach, and pericardium. The same order exists with regard to the amount of tuberculization; those organs in which we most frequently find tuberculous matter, are those, in general, in which it occurs most abundantly.[2]—C.]

The greater liability of the lungs to tuberculous deposits, has been lately ascribed by Dr. Campbell and others to the finer size of their capillary vessels, which causes them to act as filters to the blood, arresting the tuberculous matter, which is supposed to become solid in the blood itself. But this view is untenable for several reasons: 1. If the fine size of capillaries were the chief cause of the deposit, it should take

[1] Report on the Pathology of Tubercle.—Dublin Quarterly Journal of Medical Science. No. VI.

[2] Williams and Clymer on Diseases of the Respiratory Organs, p. 333.

place abundantly in muscle, the capillaries of which are even finer than those of the lungs. 2. If the cause of the first deposit were a solid matter obstructing a vessel, the appearance of vascular distension and obstruction would be obvious in the earliest formation of tubercles, and the deposit would exhibit somewhat of a capilliform shape, which is not the case. 3. The deposit has been distinctly traced by Messrs. Gulliver and Addison to be extravascular, sometimes on the surface of the air-cells, and sometimes in or under the membrane composing them. I think it highly probable that tuberculous matter may form within the bloodvessels themselves; and I have repeatedly found something presenting all the external characters of yellow tubercle in the bloodvessels of tuberculous lungs. In fact, wherever fibrine may coagulate, there its degraded form, tubercle, may occur; and I cannot but refer to the case of opaque softening of clots of fibrine in coagula in the heart and great bloodvessels as bearing on this point. Formerly, this softened fibrine was mistaken for pus: Mr. Gulliver pointed out this error by showing that it had no pus-globules. But its aspect and microscopic composition differ in no essential particular from those of soft tubercle, and the views which I have given would identify them in nature. This leads me to infer that the fibrine of blood stagnant within vessels, or extravasated from them, in tuberculous subjects, may sometimes change into aplastic tubercle. But the reasons before stated make it obvious that the early forms of tubercle are extravascular deposits, resulting from modifications of the ordinary nutritive secretion.

I believe that several circumstances contribute to render the lungs especially liable to tuberculous deposit. 1. Their great vascularity and the large quantity of blood that passes through them, which makes them largely partake of any disorder in the condition of this fluid. 2. Their being a chief seat of the formation of fibrine, that principle being more abundant in arterial than in venous blood (§ 194). 3. The softness and yielding nature of their texture, which permits effusion to take place more readily than denser textures do. 4. Their exposure to external causes of disease, whether by cold and irritations directly entering by the air-tubes, or by circumstances operating through the medium of the circulation. In hot climates, cacoplastic diseases affect the liver and other abdominal viscera more than the lungs; the same persons there suffering from chronic liver disease and dysentery, who, in a cold climate, would fall victims to phthisis.

564. As we have found (§ 562) that the cacoplastic condition of the blood of tuberculous or scrofulous subjects comprises a diminution of the red particles and a preponderance of fibrine, so we can state that the causes which develop this condition, and therefore induce tuberculous disease, are such as intelligibly induce one or both of these changes. Insufficient food, want of pure dry air, of warmth, and of light, long-continued mental depression, aggravated and prolonged disease of the digestive organs, insufficient excretion (§ 249), and the injurious influence of fevers and other serious diseases, are acknowledged causes of tuberculous disease, and may be considered to operate in both ways. Excessive evacuations of blood, or of the more animalized secretions, and severe courses of mercury, also predispose to phthisis, and perhaps

act chiefly by reducing the red particles of the blood, and the quality of the plasma. The cessation of growth, the termination of pregnancy, the stoppage of habitual discharges, especially purulent, and the amputation of a limb, all of which circumstances are known to favor the development of tubercle, may be supposed to operate chiefly by increasing the proportion of fibrine in the blood, when there is not a sufficiency of red particles, and of vital power, which is represented by them (§ 183) to give to this fibrine a due amount of elaboration and capacity for the properties of life.

565. The *treatment* of cacoplastic and aplastic deposits, and of the conditions which lead to them, involves a vast number of details, according to their kind, situation, extent, and other circumstances in which they occur. It is not consistent with the limits of this work to enter into these details; but it is hoped that a rational view of the principles on which these deposits are to be prevented and treated may be deduced from the foregoing account. This view will comprehend those measures which have the best sanction of experience.

The elements of cacoplastic diseases chiefly to be kept in view in the treatment are: 1, *the disordered condition of the blood, and its causes;* 2, *the disordered distribution of the blood, and its causes; and* 3, *the presence of the deposit, and its effects and changes.* The second element comprehends the varieties of local hyperæmia, which we have found to be so much concerned in producing the higher kinds of cacoplastic deposit (§ 553), and in promoting the formation and changes of those of a lower character (§ 560). Hence, the remedies against inflammation, determination of blood, and congestion, are frequently more or less needed in the prevention and treatment of cacoplastic and aplastic deposits. But, except as preventives, the utility of this class of remedies is generally limited to those of a topical kind. such as local bloodletting, counter-irritants, revulsives, derivants, and alteratives (§ 174). No remedies of this class have appeared to be so generally useful as counter-irritants of the milder class, rubefacients, extensively and regularly applied by friction over a large surface of the body. These operate not only as revulsives, which diminish the congestions and irritations of internal organs; but also by increasing a free circulation on the surface, which promotes the purification of the blood by perspiratory excretion, and aids the lungs in the process of arterialization.

566. The more constant and important element to be considered, in the treatment of cacoplastic and aplastic diseases, is the first named—the diseased condition of the blood; and this more demands attention, the more general and the more degraded are the deposits. The first point to be attempted is the removal or counteraction of the several causes before enumerated (§ 564), as contributing to induce the diseased condition of the blood. Thus a sufficient supply of food of a nutritive and digestible quality, comprising especially the highest order of proteinaceous articles (§ 60)—free access to a pure dry air and light, while the warmth of the body, particularly of the surface and extremities, is carefully secured by adequate clothing, and regular exercise proportioned to the strength—the removal or counteraction (so far as possible) of dis-

eases impairing digestion and excretion, and of depressing mental or bodily influences—are among the first objects to be aimed at in treating cacoplastic diseases. Where excessive losses of blood or other evacuations have contributed to lower the plastic process of nutrition, a generous animal diet, and tonics, especially those containing iron, are especially indicated. Where the altered condition of the blood can be traced to an excess of ill-developed fibrine accumulating after the cessation of growth, the termination of pregnancy, the amputation of a limb, or the sudden stoppage of an habitual purulent or other discharge—means to eliminate the superfluous matter from the blood, either by increasing the natural secretions, or by establishing an artificial drain by blisters, setons, issues, suppurating counter-irritants, &c., are distinctly indicated; whilst tonic and invigorating measures may be also useful to raise the plasticity of the blood to a higher standard. Some of the remedies to be mentioned in relation to the third indication, are sometimes useful in promoting this object also, such as cod-liver oil, nitric acid, and combinations of iodine, which have direct influence on the nutritive functions.

The foregoing measures may be considered rather as preventive than curative; but in so far as they may succeed in arresting the augmentation of deposits already formed, and in improving the nutritive function in general, they will favor the limitation of the deposits, and their gradual absorption or quiescence in contraction (556) or calcareous transformation (§ 561).

567. The third object to be regarded in the treatment, is the deposit that is already formed, with the view to promote its removal or quiescence. This end is the more difficult of attainment, and the class of diseases therefore more intractable, because, being for the most part non-vascular, the deposits are little under the influence of absorption and of the vascular currents, by which it and other changes are effected. Unlike with the euplastic products of inflammation, and, in some instances, unlike with a simply overgrown texture or organ, the changes of absorption are slow to reach deposits which are very solid and remote from vessels; and it is doubtful whether any remedy that we can use can surely promote their removal, unless, perhaps, by the simultaneous destruction of the texture which contains the deposits. The constitutional influence of mercury has seemed to me to hasten the softening and evacuation of pulmonary tubercles; but this is by such a work of destruction, and its influence on the blood has been already mentioned to be injurious. Drs. Graves and Stokes, and others, have, however, recommended mercury in the earliest stage of tuberculous disease. My own experience would lead me to avoid the specific influence of mercury, in all cases of mere tubercle; but I have given it with advantage in cases of subacute and chronic inflammation simulating tuberculous disease, and even where tubercle probably existed in a limited extent. I am less doubtful of the utility of mercury (chiefly by way of inunction), in incipient cacoplastic or tuberculous deposits on serous membranes, particularly the peritoneum, which is a general result of chronic inflammation. I have successfully treated several cases, in which the signs and symptoms left me in no doubt as to the existence of tuberculous peritonitis, by ointment of iodide of mercury to the abdomen (covering the surface with India-rubber cloth),

together with iodide of potassium internally. Whether mercury is of any use in granular disease of the liver and kidney, is a subject of doubt. Alkalies and their carbonates, and iodide of potassium, have better claims to notice, although their power to dissolve cacoplastic and aplastic deposits in the body is very uncertain. The occasional subsidence of external scrofulous tumors under their use is the best argument in their favor ; and they have this advantage, that when judiciously administered, they do not injure the blood or the constitution. They act best, and are longer borne, when combined with some amylaceous or mucilaginous material, such as decoction of Iceland moss, or fluid extract of sarsaparilla, to which may be added a little tincture of hop, or some other narcotic ; and I have found this combination frequently useful in the early stages of tuberculous disease, where there is no fever, active inflammation, or tendency to hemorrhage. Whether the iodine and alkali ever directly promote the solution or absorption of tuberculous matter, I am still in doubt ; but the signs of the presence of limited tubercles have, in many instances, diminished during their use, and the patients have regained color, flesh, and strength. Other combinations of iodine, particularly with iron, have been recommended in scrofulous disease. The iodide of iron and other preparations of this metal, I have found very beneficial in cases of anæmia, or general weakness, without much fever or local inflammation ; but I have seen no reason to suppose that they promote the removal of tubercles already formed.

568. But there are other agents which have been found of decided utility in cacoplastic and aplastic diseases, and we shall better understand their mode of operation if we again advert to the nature of the deposits, and consider what means are likely to promote their removal, by causing their solution or disintegration. Cacoplastic deposits consist of albumen or proteine, with a little (insoluble) gelatine, and minute molecules of fat contained in the granules. The more granular the deposit, and the lower in the scale of organization, the more do these fatty molecules abound ; and in opaque tubercle and atheroma they are so much increased as to coalesce and form large oil-globules, as well as some solid forms of fatty matter. The most effectual solvent of all these constituents are caustic alkalies, especially liquor potassæ, which dissolves the proteine, and forms a liquid soap with the oil. But it is impossible to administer caustic alkalies in sufficient quantity to exert this solvent power through the blood, both because they would irritate the stomach and vessels in their passage, and they would soon meet with such an amount of acid, particularly carbonic acid, as to deprive them of the greater part of their solvent power. The same objection applies to the use of acetic acid, which has been recommended with a similar object.

Other agents have been extolled which might be supposed to be useful by dissolving the fatty particles of tubercle, and thus promoting its disintegration; of this class are naphtha or pyro-acetic spirit, oil of turpentine, tar, sulphuric ether, and various fixed oils. Naphtha, which has been so highly recommended by Dr. Hastings in the treatment of phthisis, has in my hands proved serviceable in a very limited number of cases, in which, by its effect in checking profuse purulent secretion, and the cough, hectic, and wasting accompanying it, it has appeared to me to

operate like the balsams, gum resins, and turpentines, rather than by any specific influence on the tuberculous disease. So, like these, it often unduly checks expectoration, and excites pain and tightness of the chest, and hard cough, which have ended in inflammation or hemorrhage. Its utility is farther limited, like that of other medicines mentioned before, by its tendency to irritate or disorder the stomach.

Fixed oils also possess a solvent power on the fat of tubercle, and they have no such irritating or active properties towards the textures as to deter us from using them in quantities much greater than can be given of any of the above-named agents, and sufficient to justify the inference that they do exercise a very marked influence on nutrition, and do therefore thoroughly and abundantly pervade the textures of the body. But the greater number of fixed oils soon disagree with the stomach, bowels, or liver, causing nausea, inappetency, diarrhœa, bilious disorders, and other evil effects formerly noticed to result from excess of fat in food (§ 60), and this they appear to do in proportion to their proneness to absorb oxygen and become rancid, and therefore acrid, and often losing their fluidity. In these respects fish oils have greatly the superiority, being more permanently fluid and less liable to turn rancid, provided they be not contaminated with putrid matter in their manufacture (which is commonly the case, and they therefore require to be purified with animal charcoal). Of fish oils, experience chiefly testifies in behalf of that from the liver of the cod; but analogy favors the supposition that spermaceti oil, and seal oil, if equally purified, would be not less eligible, and they would have an obvious advantage in their more abundant supply, and lower price.[1] But it is important that the oil should be as free from taste and smell as possible, and, for obvious reasons, I prefer that which by cooling and settling, or by filtration, is deprived of most of the stearine. Such an oil, given in doses gradually increased to a tablespoonful three times a day, in the great majority of cases, agrees well with the stomach and bowels, increases rather than impairs the appetite, and, if continued for some weeks or even months, promotes in a marked degree the function of nutrition, increasing the strength as well as the flesh, and giving increment to all the textures. Nor is this surprising when we consider that the nuclei or rudimental molecules of all structures appear to consist of fat (§ 523), which the oil in its highly divisible state, supplies and renews in the manner most conducive to active and healthy nutrition. Its peculiar fluidity and little proneness to change also enable it to pervade all structures, and to penetrate even into imperfectly organized deposits, and by softening their concrete fatty molecules, and rendering more permeable and supple their whole mass, brings them more under the influence of the adjoining living parts, through the circulation in which, either their

[1] I think it scarcely necessary even to advert to a supposition formerly general, and still entertained by a few, that cod-oil owes its efficiency either to its offensive impurities or to any iodine which it contains. I will merely state that in some hundreds of cases in which I have prescribed the oil, the best effects have generally resulted from the use of the purest kind; and in many of these cases various forms of iodine had been exhibited without producing any of those marked changes which followed the taking the oil.

vitality and nutrition are improved and maintained, or, if incapable of improvement, they are gradually dissolved and absorbed away.

Such appears to me the mode of operation of the cod-liver oil, assuredly the most efficacious of all medicinal agents in the treatment of cacoplastic and aplastic deposits, and one which, after two years constant experience in its use, is still frequently surprising me by the wonders that it occasionally works even in aggravated and advanced cases of scrofula, mesenteric disease, pulmonary consumption, chronic pneumonia and pleurisy, and chronic rheumatism.

But no remedy, however beneficial, should lead us to neglect attention to those general and hygienic measures by which the constitutional health is promoted and sustained; or, in other words, the great functions of circulation, respiration, digestion, absorption, and excretion are promoted. Mention has so often been made of these measures, that it is needless to specify them again; and we may conclude this subject by adverting to means which may promote the absorption of cacoplastic and aplastic deposits.

That such absorption does take place, is indisputably proved by the changes in chemical composition, as well as in physical condition, that these deposits undergo in process of time (§§ 556, 561). The most salutary of these changes, and the absorption of the most injurious part of the deposits, are promoted by as free and active a circulation through and near the affected part as can be carried on without inducing irritation or hyperæmia. Hence the utility of regular exercise, and of frequent friction of the surface in the vicinity of the seat of the deposits, sometimes aided by rubefacient applications or salt-water aspersions. The more active circulation thus excited promotes the gradual solution of the deposits, chiefly by the oxidating current of arterial blood that it directs through their neighborhood; and the inquiry naturally suggests itself, can we aid this process of solution by means which oxygenate the blood more highly than can be done merely by free respiration of pure air? I have before surmised that it is probable that such agents as nitric and nitromuriatic acid and chlorate potass, may contribute to this object; and I now mention them because I have found their continued use beneficial in many cases after inflammation, in which circulation and absorption were slack, and cacoplastic effusions were accumulating and threatening mischief. So likewise in scrofulous and tuberculous disease, during the maturation and softening of the deposits, these oxygenating medicines sometimes produce decided improvement in the general and local symptoms. Their utility is limited by their tendency to irritate the alimentary canal when given largely or continued long; but they may commonly be advantageously used at intervals, when courses of cod-liver oil or of iron and other tonics are interrupted. Farther details belong to special pathology and treatment.

[The evidence in favor of the curability of phthisis seems to accumulate and to inspire us with fresh hopes and new expectations. Laennec first showed on pathological grounds that pulmonary tubercular cavities were susceptible of cure; and the observations of Andral are confirmatory. Boudet states that he met with fourteen cases in the space of a year, in which there were all the evidences of softening and of the

presence of a cavern, which had ultimately dissappeared. Another mode of cure is by the retrocession of tubercle, and its conversion into calcareous or pultaceous concretions (§ 556). Dr. Hughes Bennett has attempted to show that the cure of phthisis in this way is more frequent than is generally thought; and he supports his opinion by numerous statistical data.[1] Dr. Leeper says that, "during a period of six months, while acting as pathological assistant in the Edinburgh University, he noticed the presence of these cretaceous remains in the lungs of nine individuals who had died in the Royal Infirmary of other diseases." Dr. Blakiston has reported several cases of the complete arrest of phthisis, not only after unequivocal signs of solid deposit at the summit of the lungs, but in which actual cavities had existed during life. See his valuable work on *Certain Diseases of the Chest*. Philadelphia, reprinted, 1848.—C.]

MORBID GROWTHS.

569. Under the term *morbid growths*, or *tumors*, may be arranged certain structures developed in the animal body *in addition to* the natural textures. They differ from hypertrophy and euplastic deposits in the peculiarity of their structure; and from cacoplastic and aplastic deposits, in their possessing a higher degree of organization. In other words, they differ from hypertrophy and euplastic formations in their *kind* of vitality; and from degenerations and cacoplastic deposits in their *degree* of vitality. They are, in fact, new structures; and although some of them in general characters, and most of them in elementary composition, resemble some of the natural textures of the body, and although all derive their nourishment from the blood, yet, in their origin and growth, they are more essentially distinct from the natural structures than are any of the results of diseased nutrition hitherto considered. For these reasons, they have been called *new* and *parasitical* growths; and the term *parasitical* is the more applicable to them because their existence and mode of growth cannot generally be traced to variations in the local circulation, which we have found to be chiefly concerned in producing and influencing the modifications of nutrition hitherto noticed.

Morbid growths have been divided into *analogous*, those whose structure resembles some natural texture (including false membranes, &c.); and *non-analogous*, or *heterologous*, those which have no parallel in the healthy state of the animal economy. But this division is inconvenient because it is applied to the other products of diseased nutrition previously arranged under another division (hypertrophy and deposits); and it is often inapplicable, inasmuch as many morbid growths are essentially compound, comprising some forms that resemble natural textures, others that do not; yet all these are constituted of similar elementary molecules; this remark especially applies to carcinoma.

The division which I have adopted into *non-malignant* and *malignant*

[1] Edin. Med. and Surg. Journ. No. 163, April, 1845, p. 406.

is more useful in a practical point of view, although it may not be easy to make it precisely applicable to all cases.

SECTION VII.

NON-MALIGNANT GROWTHS.

570. I would apply the term non-malignant to those growths, or tumors, which occur in a part of the body, without tending to infect other parts; and which arise among, but do not invade or penetrate the natural structures; and, if they prove injurious, it is by their bulk or position, or by the extent to which they abstract the nourishment of the body.

571. The most simple forms of new growth are *serous cysts*, which consist of a shut sac, "containing serum, and formed of condensed cellular substance resembling serous membranes, which are formed gradually around a clot of blood, or any foreign substance in the system; and are frequently developed spontaneously in various parts of the body. They are frequently attached to the natural serous membranes, but sometimes quite separate from these; sometimes solitary, sometimes set together in clusters; and their size and shape are very various. They must be distinguished from enlargements of natural cavities, such as the calices of the kidneys, or Graafian vesicles in the ovaries. They are often unconnected with disease of the adjacent textures; but in some cases, these textures are found either wasted by absorption (atrophy from pressure, § 532), or disorganized by inflammation around them. There is no evidence of their being generally connected, in their commencement, with inflammatory action; and when they are small, their existence is often not denoted by any symptoms whatever."[1]

Besides the instances above excepted from this class of new growths, may be mentioned several others, which are rather instances of hypertrophy, dilatation, or unusual development of a natural structure, and therefore belong to a former division (§ 528). The enlarged bursæ, in parts subjected to pressure; the dilated mucous follicles, in the cervix uteri; the cutaneous follicles distended with fatty or other matter (epidermis scales), constituting the subcutaneous *adipoma* and *meliceris;* the salivary ducts obstructed, and filled with concretion, in the tumor called *ranula*, are of this kind, and do not belong to the present division. I would, with Dr. Hodgkin, extend the same remark to the small serous cysts frequently found in the kidneys and liver, which I have before described as portions of secretory ducts obstructed and distended with serum, (p. 193, *note.*) It may be fairly questioned whether other serous cysts are not also due to enormous enlargement of the primitive or compound cells of which textures are partly composed. My friend, Dr. Hodgkin, has most plausibly advocated an opinion of this kind, and has applied it also to explain the production of more solid and complex

[1] Alison's Outlines of Pathology, p. 201.

growths, by the formation, multiplication, and compression of a series of cells.[1]

572. Cysts, somewhat like the serous cysts above described, are sometimes found filled with different unorganized contents, and then constitute the simplest kind of *encysted tumors*, which form in various parts of the body that have a cellular structure, and they have received names descriptive of their contents: *hygroma*, when they contain a nearly serous fluid, and form encysted dropsy, if they attain a large size; *hæmatoma*, when their contents are bloody; *steatoma*, or *lipoma*, when they are of a fatty nature; and *atheroma*, when they contain an opaque pulpy matter of plaster-like appearance.

These cysts are probably often formed in the first instance of extravasated blood or fibrinous matter, the exterior of which becomes organized into a sac, the inner surface of which, according to Vogel, secretes an epithelium; whilst the interior is more or less removed, and either gives place to serum, which may be more or less thickened by epithelium scales, or may become converted into fatty or even osseous matter, in the same manner as aplastic deposits (§ 561), and the contents of old abscesses.[2] When such tumors form under the skin, they often contain epidermis scales, which may render their fluid opaque and thick, or by agglutination may concrete into a horny solid. In the vicinity of hairy parts, they often contain hair. In some instances cholesterine has been found in them in great abundance; not only in cysts connected with the liver, but in those large and often compound cystiform tumors connected with the ovaries. In these last organs, cysts have also been found inclosing perfectly formed teeth and bones, as well as hair.

573. Complex cystiform tumors are more complicated in their structure exhibit farther deviations from the natural organization. They are chiefly developed in connection with glandular organs or those having cysts or vesicles, as the ovaries.

A still more complex and organized kind of tumor, is that generally designated by the term *sarcomatous*, which consists of organized solids of considerable variety, but generally bearing a resemblance to one or more structures naturally existing in the body, and generally in the part in which the tumor grows. Thus we have *fibrous tumors*, consisting of densely compacted fibres, scantily supplied with bloodvessels, generally slow in their growth, and like fibrous deposits liable to ossification. *Steatoma*, or *adipose sarcoma*, which resembles natural adipose texture; but is often rendered more dense by combination with a fibrous structure;—*Chondroma*, or *cartilaginous tumor*, which forms rounded masses having much analogy to cartilage, but may also be combined with *bands of fibrous* texture, and are liable to ossification;—*Vascular tumors* (*Hæmatoma*, *erectile tumors*), which consist of a congeries of bloodvessels of considerable size, apparently enlarged capillaries, with more or less connecting filamentous tissue. These last present varieties

[1] Med.-Chir. Trans. vol. xv. part 2.

[2] Vogel suggests that similar cysts with various contents may originate in old abscesses which have never opened, and the pus in them has gradually undergone a change. Cysts in the liver, containing a gelatinous, and in some instances a putty-like matter, commonly passing for tubercle, appear to have been produced in this mode.

dependent on the freedom with which they communicate with arteries; when supplied by large arteries they are florid in color, they pulsate, and if large, the pulsation is attended by a blowing or rasping sound as in vascular bronchocele; when the arterial communication is not free, the tumors exhibit the darker hue of venous blood.[1]

Dr. Hodgkin considers that the complex cystiform tumor, as it occurs in the ovary, exhibits a type of the origin of morbid growths in general, not excepting those of a malignant kind. From the internal walls of one original, or parent cyst, there spring a number of other cysts, varying in their contents; and as they grow, they fill the original cyst, and project beyond it, other cysts being produced within them; and thus a growth takes place, subject to modifications from the nature of the texture which is its seat, as well as from the contents of the cysts. In solid structures, as dense cellular membrane, the cysts are so compressed as to present the appearance of fibres radiating from a centre, and they lose all their liquid contents. The adjoining textures, as well as the walls of the cells, may also inflame and cohere, so as to obliterate the cystiform structure of the tumor.

574. The pathological cause of morbid growths is involved in much obscurity. We cannot at present go beyond the supposition that they arise from altered vital properties in some of the molecules of the textures in which they are developed; so that, instead of being assimilated to these textures, and conforming to the laws of their growth and decay, these molecules grow of themselves in modes more or less peculiar, and more or less independently of the influences of the adjoining living parts. Where these modes are less peculiar and more dependent on the nutrition of the adjacent structures, the growths are less abnormal, vary less from these structures, and in their origin and course more resemble either hypertrophy (§ 525) or euplastic deposits (§ 547), and they do mischief rather by their size or situation than from their intrinsic nature. Where the mode of growth is more peculiar and more independent of that of the textures in which they arise, the resulting tumors are more abnormal in their nature and mode of development; they approach in character to malignant disease, acting injuriously, not only by their bulk and position, but also by abstracting the nourishment of the body, and by tending to supersede the natural structures.

575. At the outer limits of the non-malignant growths, may be classed those peculiar bodies called *hydatids*, or *acephalocists*. These are more peculiar in structure and contents than any other morbid growth, and they are quite detached from the structures in which they occur. They may, therefore, be inferred to possess a vitality quite independent of that of these structures. Their vitality is low, but indisputable, and is exhibited (1) in their power of self-nutrition, as manifest in the growth and the peculiar structure of their walls, which are much more elastic than any normal animal texture; (2) in their power of secretion, shown by the peculiarity of their contents, which are limpid and colorless, whatever be the nature of the matter in the serous cyst which separates them

[1] For farther particulars respecting the pathological character of tumors, see Vogel's *Pathological Anatomy*, by Dr. Day, [Philadelphia, reprinted, 1847.]

from the living textures ; (3) in their power of reproduction by gemmation, the young being developed between the layers of the parent cyst, and thrown off, either internally or externally, according to the species. Professor Owen[1] describes the hydatid to be "an organized being, consisting of a globular bag, which is composed of condensed albuminous matter, of a laminated texture, and containing a limpid colorless fluid, with a little albuminous, and a greater proportion of gelatinous substance." He adds : "As the best observers agree in stating that the acephalocyst is impassive under the application of stimuli of any kind, and manifests no contractile power, either partial or general, save such as evidently results from elasticity—in short, neither feels nor moves—it cannot, as the animal kingdom is at present characterized, be referred to that division of organic nature. It would then be a question, how far its chemical composition forbids us to rank the acephalocyst among vegetables. In this kingdom, it would obviously take place next those simple and minute vesicles, which, in the aggregate, constitute the green matter of Priestley (*protococcus viridis*, *Agardh*) ; or those equally simple, but different colored *psychodiariæ*, which give rise to the red snow of the arctic regions (*protococcus kermesianus*). These, first-born of Flora, consist, in fact, of a simple transparent cyst, and propagate their kind by gemmules developed from the external surface of their parent."

The researches of Schleiden, Schwann, and their followers, have thrown some light on the possible origin of hydatids, by showing that the primitive cells of animals, as well as of vegetable structure, are often not unlike hydatids in their anatomical composition, growth, and mode of reproduction ; for the hydatid appears to be a nucleated cell, from the interior of which are developed nuclei and nucleoli, the germs of young cells. But if it be presumed, in accordance with this fact, that hydatids are really *offsets* of living structures, capable of living detached from the solids of the body, it still remains a mystery how this divided or detached life is acquired by certain molecules on rare occasions, and contrary to the usual law. We might, perhaps, imagine some analogy between hydatids and the polype tribe of animals, which may be indefinitely propagated by division ; and it might be conjectured, that the conditions of the body in which hydatids are most commonly found, might reduce the plasma of certain parts to the standard of this mode of life ; but these subjects are too speculative to be dwelt on here.

576. The situations in which hydatids have been most commonly found, are the liver, the lungs, the spleen, the kidneys, and the ovaries. M. Andral records an instance in which he found hydatids in the blood within the pulmonary veins ; there was also a large cyst, full of hydatids, in the liver. The condition of the system in which they have been most frequently found to occur, is one of cachexia and malnutrition. They are usually contained in a serous or protective cyst (§ 571), formed by the texture around them ; and the symptoms which they occasion are merely those caused by their bulk and position, compressing, displacing, and irritating organs, and causing atrophy and inflammation of their

[1] "Cyclopædia of Anatomy," &c., article *Entozoa*.

textures. In the cyst which contains them, there is commonly found more or less opaque laminated matter, which appears to be the debris of collapsed hydatids; indeed, some of them retaining the globular form, often exhibit the commencement of this decay, in an opacity and wrinkling of their walls, and a changed color of their contents. But I have likewise found a considerable quantity of an opaque, yellowish, pultaceous matter mixed with the collapsed hydatids, and lining the containing cyst; under the microscope it appeared to consist of granular matter, and imperfect cells, with much fat; and in one instance, where the hydatid's sac lay between the liver and the diaphragm, there were abundant crystals of cholesterine; I therefore regard this opaque matter as a deposit from the surface of the sac, degenerated into aplastic and fatty matter.

577. The *echinococcus* is a variety of hydatid, differing from the preceding chiefly in its having a yellowish and tougher outer tunic, and in its containing distinct animalcules within it (*vermiculus echinococci*). It has been found in the liver, spleen, mesentery, and substance of the heart, and rarely in the urine. The *cysticercus* is found in muscular structure, and in one instance was seen in the aqueous humor of the eye. It has a distinct structure, consisting of a cystiform body and a head provided with suckers and hook-like processes for attachment. The *distoma hepaticum*, or *liver-fluke*, is rarely found in the human subject. It is the supposed cause of the rot in sheep, and was found by Andral and Delafond in those animals in which dropsy was present, and there was a defect of albumen in the blood (§ 222). The rot is a disease which chiefly attacks sheep fed in wet clayey pastures.

The subject of intestinal worms belongs properly to special pathology.

578. Little can be said on the *medical treatment* of morbid growths. To those of the kinds most approaching to the natural textures may be extended the observations applied to hypertrophy (§ 529) and euplastic deposits (§ 552). So far as they originate from, or are augmented by, local determination of blood, or any other kind of hyperæmia, the remedies for these morbid elements may retard the increase of the growths. But as we have found that the chief peculiarity and cause of these growths is an alteration of the vital properties of the primitive molecules of textures, little is to be expected from measures which act only on the quantity of the nutritive material. In fact, we have seen that, in many instances, morbid growths seem to originate in connection with a depressed rather than with an exalted condition of the vascular functions; and in those last noticed, which bear more distinctly the character of parasites, the general or constitutional powers are weakened in proportion as these are developed. Hence, the general treatment indicated in such cases is of the supporting and tonic kind, with due attention to the regulation of the digestion and of the secretion. But this treatment will require modification when the morbid growths, by their irritation or pressure, excite a considerable amount of inflammation, or even of local obstruction to the circulation.

We are not acquainted with any medicinal means of correcting those alterations of vital properties in the molecules or textures from which

morbid growths take their rise. The same spontaneous power which places these growths beyond the controlling influence of the laws of textural nutrition, removes them beyond the reach of general remedies. The surgeon can in some instances remove the diseased part by the knife, and can sometimes farther modify its properties by the direct application of escharotics, or caustics, which destroy the morbid cells or germs which are the roots of the growth; and where this can be effectually done without serious injury to other living parts, the cure may be complete. Mechanical pressure carefully and steadily applied so as to diminish the supply of blood to the tumors without interrupting the circulation in other parts, has sometimes been effectual in restraining the increase, and in some cases in promoting the absorption of morbid growths. It is doubtful whether the physician possesses any means of aiding the surgeon in these cases, or of controlling morbid growths which are beyond the reach of the surgeon, farther than those calculated to promote the general health of the body.

In many instances, the secondary pathological changes induced by morbid growths, such as inflammation, congestion, dropsy, flux, &c., are the chief objects of treatment, and may often receive much benefit from the usual remedies; but the extent of this benefit is commonly limited, as to extent and time, by the permanency and intractability of the morbid growth, which is their cause. Thus with encysted dropsy of the ovarium, peritonitis, ascites, and œdema, obstruction of the intestines, and other secondary functional disturbances, generally admit of relief for a time; but as the ovarian tumor remains, and may increase in spite of all remedies, the resulting disorders recur again and again, and at last prove fatal. But the growth of the cysts themselves, although generally progressive, may be very capricious—being sometimes very rapid; in other instances, even in the same case, it may remain stationary for years. Nay, cases are not wanting, although rare, in which encysted tumors have altogether disappeared: as after the operation of tapping, or even spontaneously, by rupture, into some of the natural cavities. But such instances, although they show a variety exhibited by morbid growths, not to be forgotten in connection with prognosis as well as treatment, are to be considered rather as exceptional cases, than as those following the usual rule.

SECTION VIII.

MALIGNANT GROWTHS.

579. *Malignant growths* are distinctly organized structures, arising in various textures of the body, invading these and contiguous textures with their own peculiar substance, and often appearing successively or simultaneously in several parts of the body. There is perhaps no character more indicative of malignancy than the disposition to pervade and penetrate the several structures of a compound organ, and even to form attachments to those adjacent, and thus to unite several distinct

textures and even organs into one morbid mass; in this respect they contrast with non-malignant tumors and deposits, which push aside, compress, or distend the structures in or near which they are developed, but never penetrate through them. Malignant growths thus prove injurious, and eventually fatal, not merely by their bulk and position (§ 569), but also by the change of structure which they may induce in various organs; by the intractable ulcerations and fungous wounds to which they tend; and, lastly, by a wasting and deleterious influence which they seem to exercise on the whole functions and structures of the body. In all these points, the most malignant growths exhibit a character perfectly distinct from the more simple, harmless growths hitherto described; but it must be observed, that the degree of malignancy varies very much in different cases, by one or more of the preceding characters being absent, or not yet well developed; and, consequently, that morbid growths or tumors are occasionally met with, which present a doubtful or intermediate character between non-malignant and malignant.

580. The names *cancer* and *carcinoma* (from the supposed resemblance of the diseased structure to a crab, *cancer*, καρκινος, which suggests the apt image of numerous claws penetrating and attacking adjacent parts), have been long applied to the whole genus of malignant growths, which comprehends the following varieties: *Scirrhus; mammary, pancreatic, and solanoid sarcoma; encephaloid*, or *medullary sarcoma; fungus hæmatodes;* and *colloid*, or *gelatinous cancer*. That these are all varieties of the same disease, may be inferred from the fact that they more or less resemble each other in the characters of malignancy above described; and that they frequently occur in the same subject, either simultaneously in different parts, or successively in the same part. Thus a person who has long been affected with scirrhus of the breast, often dies with medullary sarcoma in the liver or lungs; or after a scirrhous tumor has been removed from any external part, an encephaloid or fungous disease may subsequently appear in its place. The varieties may, for the most part, be traced to different degrees of activity in the *specific* or *cancerous matter*, that may now be stated to be the *materies morbi*, and to the varied changes in the new growth, and in the implicated textures which this matter, thus differently active, can produce. Of these varieties, it may be said generally, that scirrhus, and perhaps the mammary and pancreatic sarcoma, exhibit a *chronic* character, with less activity and tendency to increase locally, or to spread through the system; whilst the others constitute the more acute forms of cancer, causing more rapid growth in the parts first affected, and more speedily appearing in other parts of the body.

581. The peculiar matter of cancer is distinctly a structure consisting of nucleated cells and molecules, contained in an areolar or fibrous web of various density. Of these, the cells must be considerd the first elements; and although they present some variety in form, they are constantly found in every kind of cancer. These cells are chiefly globular, and retain that shape in the soft, gelatinous kinds of cancer; but in others, many are caudate, or spindle-shaped, as if in the process of transformation into fibres. Into scirrhus, and other more solid and chronic forms of cancer the fibrous structure is more abundant, and is

very perceptible to the naked eye, forming glistening striæ, or bands, radiating through the mass, of cartilaginous hardness; the cancerous cells and numerous granules are seen between these fibres and accompany them to their outermost branches. In the cerebriform or medullary kind of cancer, the nucleated cells are very numerous; and the texture in which they are contained is cellular, and well supplied with vessels. This is the species in which the growth is most rapid, and in which, from the extravasation of blood in the loose new texture, a bloody aspect is given to parts of it, whence the name *fungus hæmatodes*.

582. The intrinsic disposition to grow, even at the expense of the nutriment of other parts of the body, which was mentioned to be a character of some formations not distinctly malignant (§ 574), is exhibited in a much higher degree in malignant structures, the increase of which may take place most rapidly when all the natural textures are wasting away. This fact again suggests the idea of an independent vitality possessed by these structures, in virtue of which, like parasitic animals or plants, they luxuriate at the expense of the whole frame. The question next arises: Are these growths truly parasites, arising from ova or seeds derived from without the body, and after entering it, and finding a proper nidus, or soil, taking root or becoming developed as a distinct being like worms or hydatids, and drawing its nourishment from the fluids and solids of the body? If it be objected that malignant growths are too closely attached to, and too much identified with, the textures of the body to permit the notion of a distinctness of being, it may be replied, that cancerous cells, their most distinctive part, are often loose and unattached; they propagate themselves by the production of young cells within them; and in this mode become disseminated, first in contiguous parts, in which they appear to take root and extend their attachments; and subsequently, through the channels of the blood-vessels, which in extensive forms of the disease have been found to contain cancerous masses. An experiment of Professor Langenbeck was supposed to have proved that the cancerous pulp containing these cells is capable of propagating cancer in animals on being injected into their veins, but the attempt has been frequently made by others without any such result. Should such an experiment be made to succeed, it would positively identify cancer with contagious diseases, respecting the causes of which we formerly noticed questions like the present, as to their parasitic nature (§ 99). Contagion is not, however, a common cause of cancer; the only example ever adduced being the rare one of the penis becoming infected by a carcinomatous os uteri. Farther, it has been well remarked, by Dr. W. Budd,[1] that the causes which have been supposed to induce cancer are not such as can, in any intelligible way, favor the introduction of germs from without the body. Thus, in chimney-sweeps and others, the continued application of soot has been observed to be followed by the occurrence of cancer in the scrotum, in such a number of cases as to justify the inference that it has been the exciting cause. The often repeated contact of a tobacco-pipe with the lip, has also been considered a cause of cancer of that part. But

[1] Remarks on the Pathology and Causes of Cancer, *Lancet*, May 28, 1842.

neither of these causes can, in any conceivable way, promote the development of cancer from extrinsic germs.

The alternative that presents itself is, that cancerous growths may arise from a peculiar perversion of the natural nutritive process, similar to those modifications which we have been induced to suppose are the causes of the more peculiar kinds of common growths; but in the case of malignant disease, the perversion is much greater in degree, and shows itself, not only in its origin, but in its whole subsequent history. It can be conceived possible, that causes long acting locally, as the soot on the scrotum of chimney-sweepers, the tobacco-pipe on the lips of inveterate smokers, the irritations of the stomach connected with habitual dyspepsia, and of the uterus from irregular menstruation, &c., may induce this extraordinary alteration in the molecular nutrition of these parts; but we cannot hereby at all explain the peculiarity of this alteration, which must therefore be viewed as an ultimate fact in connection with nutrition. In other words, if we assume that cancer-cells are modifications of the natural cell-germs by which textures are produced and nourished, we do not thereby explain (or refer to a known law) the extraordinary anomalies of the independent vital properties and consequent growth of these modified cells, which are obviously different from that of texture cells in general, and derive much of their destructive effects from such difference. It remains for future investigation to establish the law of that difference. We have before stated, that Dr. Hodgkin has proposed a plausible hypothesis with regard to these and other growths, that they originate in cysts (not cells or microscopic cysts, but larger ones, which comprise these); and that the multiplication of these cysts within each other, their prolongation into radiated fibres, their pressure on adjoining textures, and consequent inflammation, induration, ulceration, atrophy, or gangrene of these textures, comprise the whole history of malignant growths. What appears to me to be chiefly wanting to establish Dr. Hodgkin's views, is a more distinct demonstration of the supposed cysts, which, at the commencement, or at the outer limits of cancerous growths during their spread, ought to be distinctly visible.

583. But although the precise origin of malignant growths is still a matter of uncertainty, some important practical facts may be gathered from their pathology. Their microscopic structure and history pretty clearly show that they are of local origin; that they extend by the multiplication of their cells, which, by perverting the nutrition of the adjacent parts, cause the growth of the tumor; that they ultimately infect other parts of the body, by spreading to the nearest lymphatic glands, and by the mixture of their cell-germs with the blood (§ 259), which form new tumors in the liver, lungs, or other vascular parts, (the same as those in which purulent deposits take place, and for similar reasons) (§ 470); or the cancerous matter is sometimes found in clots within bloodvessels, or in the coagulable lymph effused by inflammation.[1]

[1] In a case (which I saw with Mr. Avery) of malignant disease of the lungs and deep cervical glands, involving the 8th nerves, there had been recent pleurisy, and the bands of false membrane were glistening, and grated under the scalpel from the presence of cancerous fibres.

But the history of malignant growths comprises not only that of the development of the cancerous structures in different degrees and forms, but also their effect on the adjacent textures; and it seems to me possible, by a due regard to these two elements, to explain much of the varieties which cancerous disease presents. Thus scirrhus is the slowest form of the disease, because it generally occurs in persons above the age of forty, in whom the textural nutrition is tardy, and the cancerous matter is but slowly developed; the effect on the adjacent textures is to excite inflammation of a chronic form, and therefore leading to induration, and often to contraction (§ 479), and more or less obliteration of the natural textures. Hence the hard, knotty, corrugated swelling of scirrhus of the mamma, rectum, pylorus, &c., which may be attended with more or less pain of a peculiar stinging or lancinating character, besides various functional disturbances (obstruction to the passage of food or feces, severe dyspepsia, vomiting, &c.). The continuance of irritation in the indurated parts leads (as usual) to ulceration (§ 466). This constitutes what is called *open cancer*, with ragged, inverted, or everted edges, and a fungous or sloughy interior, discharging a dark, offensive, ichorous matter. That such ulcers should be wholly incapable of healing is quite intelligible, when it is remembered that its walls are composed of the cancerous structure and the compressed remains of the natural textures, whose secretions are too poor and too much perverted to afford euplastic secretion. The ulcer may prove an outlet for the increasing cancerous matter; and if the discharge be checked by external means, the disease is more likely to spread or to attack other parts. As the ulceration destroys the indurated mass, and thus removes the barrier between the cancerous germs and the healthy textures, there is a greater chance of the body becoming more generally infected. Hence, too, from the multiplication and diffusion of the germs, the secondary malignant growths that may appear in other parts are often of the softer, more rapidly-growing kinds. The influence of scirrhous cancer on the whole frame, although more slowly induced, perhaps for this very reason, is carried to a greater degree than that of any other form of cancer. Emaciation sometimes reaches a point unequalled in any other disease; and the wasting, of which this is the sign, extends to the composition as well as to the bulk of organs and textures. Thus bones lose much of their animal matter, and become so brittle, as sometimes to be fractured from the slightest violence. All membranes become extremely thin; the omentum often wastes away, excepting a few threads. The lungs exhibit a remarkable lightness, in weight and color; and I have seen the old cicatrices, or consolidations, so frequently found at their summits, thinned and almost as pliant as other parts of the pulmonary texture.[1] But nothing is more remarkable than

[1] It appears to me that the rare coexistence of tubercle with cancer, as noticed by some writers, is to be ascribed to the former being removed by absorption during the extraordinary wasting of textures which attends chronic cancer. I have twice found, in the bodies of persons who died of cancer, considerable remains of tuberculous deposit at the apex of the lungs, without any tubercles in other parts. In one case, masses, partly caseous, partly calcareous, of the size of a pullet's and a pigeon's egg, were thus found encysted by a thin membrane. In another, a cavity communicating with the bronchi, traversed by a band of dense tissue, like that found in tuberculous cavities, and lined with a thin, smooth membrane, was in the middle lobe. In all these cases the other parts of the lungs were free

the exsanguine state of the textures generally; and this condition is obvious during life in an extreme pallidity, often associated with a sallowness, or peculiar lemon-tint, of complexion, that has been observed to be peculiar to cancerous subjects.

Scirrhus chiefly occurs above the age of forty; and the more advanced the age, the slower generally is the progress of the disease. It has been remarked, by Sir Charles Bell, Sir Astley Cooper, Mr. Travers, and others, that scirrhus of the breast, which will run a comparatively rapid course at the age of forty-five, will remain stationary for years, and hardly appears to shorten life at the age of sixty or seventy. This shows the share which activity of textural nutrition has in causing the increase and dissemination of cancerous disease. It is under such circumstances that operations for the removal of the disease have been most successful; but it must be remembered, also, that in such cases they are less strongly called for.

584. The *pancreatic mammary lardaceous* (or pork-like), and *solanoid* (or potato-like), forms of cancer appear to be intermediate between scirrhus and encephaloid disease, increasing more rapidly than the former, yet approaching to it in firmness. They are attended with less pain, from the smaller degree of tension and induration which they cause in the implicated textures. For the same reason, they are less disposed to ulcerate (§ 466) or slough (§ 474); and they commonly prove fatal, either by their growth and encroachment on some vital part, or by leading to the dissemination of cancerous deposits in other parts of the system.

585. *Encephaloid* (brain-like), or *medullary sarcoma*, is the acute or rapid variety of cancerous growth. It occurs chiefly in young and middle-aged subjects, and in the most vascular textures; and it may be fairly connected with the activity of their molecular nutrition. This may be the cause of the rapid increase of the cancer-germs, or cells (if these be indeed mere modifications of the cell-germs of textures); and their elongation and growth into remarkably large and sometimes branching fibres, forming the stroma or web of the cancerous growth; but much of the speedy increase and early dissemination of this variety of cancerous disease, must be attributed to an active plastic process, which the presence of the cancerous matter excites in the vascular textures in which it lies. The mass of encephaloid tumors comprises false membranes, lymph, and even coagula of blood, in various degrees of organization; among and between these are found the cancerous cells and fibres, which luxuriate and rapidly multiply in so fertile a soil. It is in connection with tumors of this kind that the fact before noticed has been observed, that coagula in the neighboring veins have exhibited the encephaloid appearance; and so has coagulable lymph produced by inflammation of serous membranes or parenchymata of organs. The speedily destructive influence of this kind of cancer is mainly to be ascribed to

from tubercles. Now, it does not appear probable that such considerable tuberculous deposit should have taken place without some in other parts also. We meet with no case of recent tubercle thus limited to one portion of the lung. These and similar facts connected with the emaciation of old age, seem to me to furnish additional arguments in favor of the absorption of tubercles (§ 561).

the rapid dissemination of the cancerous matter, and the bulky deposition which it induces around it, which, although organized, and highly vascular, are beyond the controlling influence of the powers of assimilation or absorption, and consequently penetrate, obstruct, or compress organs to a fatal extent. The facility of growth in these tumors receives some explanation in the varicose condition of their vessels, as ascertained by Mr. Kiernan, and their free communication with arteries (§ 420), as pointed out by Schroeder Van der Kolk. The same circumstance, together with the general softness and looseness of their texture, accounts for the facility with which hemorrhage takes place into their substance (§ 357), causing an appearance that has led to the use of the term *fungus hæmatodes*. These forms of disease commonly prove fatal before the emaciating effects, so remarkable in scirrhus, have advanced far.

586. The *colloid*, or *gelatinous* (*areolar* of Cruveilhier) variety of cancer seems to me to represent the cancerous element almost in a separate state, little mixed with natural tissues or their products. According to Müller, it consists chiefly of cells contained in a very slight loose web; the cells are larger and rounder than usual, and contain small cells, which also contain cell-germs. The peculiar germinal principle of cancer is here, therefore, very abundant and prolific; but the nutritive secretion of the surrounding textures is not equally copious; therefore no distinct growths are formed; but the gelatinous matter is found infiltrated into the webs of textures, chiefly in connection with advanced stages of other forms of the disease.

Farther varieties have been described, by Dr. Carswell and others, according to the particular form which the cancerous growth assumes, such as the *tuberiform*, *stratiform*, *ramiform*, &c. They are probably connected with the anatomical construction of the parts in which they appear, together with the quantity and rapidity of development of the new growth.[1]

[In the very interesting paper of Dr. Hughes Bennett, in the *Edinburgh Monthly Journal*, the anatomical characters of cancer are thus described. A cancerous growth may contain the following elementary structures: 1. Molecules and granules; 2. Nucleated cells of various shapes; 3. A filamentous or fibrous tissue; 4. A viscous fluid; 5. Bloodvessels; 6. Fatty matter; 7. Pus, and compound granular cells; 8. Black pigmentary matter; 9. Earthy matter. Of these, some are accidental or only occasional, and others essential or invariably present. The essential elements of cancer are: 1. A fibrous meshwork, or stroma; 2. Nucleated cells; 3. A viscous fluid in which these float.

The fibrous tissue of cancerous growths exactly resembles that found in lymph or in the healthy tissues of the economy. It may be formed either by deposition or by means of cell-growth. In the former case, filaments more or less delicate, and closely aggregated, may be seen crossing each other, or running in bundles, forming various kinds of meshworks, in which the cells of cancer are deposited. In the latter

[1] Many interesting particulars respecting the microscopic characters of cancer will be found in Vogel's *Pathological Anatomy* (by Dr. Day), and in the *Edinburgh Monthly Journal*, by Dr. Hughes Bennett, October and November, 1847. These have appeared since the publication of Dr. Walshe's elaborate *Treatise on Cancer*.

case we can observe fusiform cells splitting up into fibres, and are able to trace their formation from round, oval, or caudate cells, until perfect fibres are formed. These cells (called by Lebert, *fibro-plastic*) are of a round or oval form, varying in size from the 1-100th to 1-50th of a millimeter in diameter. Sometimes they possess a distinct nucleus, about the 1-130th of a millimeter in diameter; at others, contain only several molecules and granules. Acetic acid causes these bodies to undergo very little change. They become somewhat paler, but there is no marked difference in this respect between the nucleus and cell-wall. These cells, in their different stages of development into fibres, have been frequently mistaken for those of cancer. Müller placed them among cancerous growths; and hence the erroneous opinion that the caudate, or spindle-shaped cell is characteristic of cancer. Fibrous tissue may be arranged so as to form loculi, containing a viscous fluid with or without cancer-cells, constituting the colloid tissue of authors.

The nucleated cells peculiar to cancer vary greatly in shape and size. Sometimes we see nothing but oval bodies about twice the size of a human blood-globule, or closely resembling, except in color, the oval blood-corpuscles of the lama or camel. They measure about the 1-75th of a millimeter in length, and 1-100th or 1-120th of a millimeter in breadth. These oval bodies are the nuclei of cancer-cells. Sometimes they exist alone; at others we may observe, by careful management of the light, a round or oval delicate cell-wall, frequently resembling a mere shadowed halo, in the fluid in which it floats. On adding acetic acid to them, we find the cell-wall disappear, whilst the nucleus becomes more distinct than formerly. Such is the character of a cancer-cell in its young state. At a more advanced period of development, the cell-wall is more distinct. The nucleated structure is now round or oval, its medium diameter being about the 1-50th of a millimeter, with a round or oval nucleus about the 1-100th of a millimeter in diameter. The addition of acetic acid always produces a remarkable change in these bodies, causing the cell-wall to become very transparent and faint, and the nucleus to assume an unusual degree of distinctness. Hence Dr. Bennett considers that Dr. Walshe has committed a fundamental error in his histology of cancer, when he says (p. 33 of his treatise) that "the ultimate microscopical cells of cancer are insoluble in cold and boiling water, and are not seriously affected by acetic acid."

Dr. Bennett minutely describes the farther growth of these cells, showing how they multiplied from cell rising within cell. It is owing to this cellular structure that cancer owes the reproductive power which constitutes its malignancy. The cells occur insulated or in groups, surrounded by the other elements of the growth, but more especially by the fibrous tissue.

The third essential element in cancer is a gelatinous fluid. On cutting through a scirrhous tumor, however hard it may be, we may generally succeed in scraping from its surface a fluid more or less transparent. In soft cancer it is more abundant, and contains the granules and cells previously described. In some forms of cancer, however, it constitutes a very large proportion of the mass, presenting a gelatiniform or mucilaginous appearance, varying in color from a pearly white to a deep

amber, and in consistence from a slightly viscous fluid to a firm semi-solid mass. Collections of this kind may occur in loculi formed by fibrous tissue, or in cystic tumors perfectly structureless, or containing only numerous molecules and granules constituting the simple colloid tissue of Gluge and Lebert. When associated with cancer, however, it contains a greater or less number of the cells previously described, in various stages of their development.

It is the relative amount of the three essential elements of cancer now described which constitutes its peculiar form. If the fibrous element be in excess, it constitutes scirrhus. If the corpuscles be numerous, encephaloma is produced; and if the fluid abound, and is collected into loculi, we call it colloid cancer. There is no other difference between these three forms than this.

At an early period in the study of histology, it was natural to conceive that a certain *form* of the cell should be thought characteristic of cancerous growths. The observation of Müller led to the belief that the caudate and spindle-shape of this minute structure was peculiar to them. Hence we find him confounding certain tumors long denominated sarcomatose, and which wholly consist of fusiform cells, with cancerous or malignant growths. These, however, have no power of reproduction; and, although often associated with cancerous cells, should not be confounded with them. From the results of many examinations, Dr. Bennett is satisfied that there is no one form of cell which can be considered as at all times characteristic of cancer. The caudate and spindle-shape of these bodies is common to fibrous structures in general, frequently seen in lymph, and especially in the exudation forming the granulations on ulcers, recent wounds, vegetations on the endocardium, &c. &c.

The *structure* of the cell and the action of acetic acid upon it are much more distinctive. If the corpuscles are in that stage of growth in which they present a distinct nucleus with contained nucleoli, and if, on the addition of acetic acid, their external wall be rendered more transparent, whilst the border of the nucleus is apparently thickened, they are highly characteristic of a malignant structure. But even this is not an absolute and invariable mode of distinction; besides, it is only applicable when the cells have arrived at a certain stage of development. Dr. Bennett has frequently seen young epithelial cells, under certain circumstances, present all the characters just mentioned, with the exception of inclosed nucleoli, and undergo the same reaction with acetic acid. This is very apparent in some cases, where effusion has taken place into the lateral ventricles of the brain, when the epithelial cells of the choroid plexus become separated, swell out from endosmosis, assume a globular form, and the cell wall, if young, is partially dissolved in acetic acid, whilst the nucleus is unaffected. The same occurs with the epithelium of the bladder. He has found in the bladder a fluid having all the external appearance of pus, and on examination shown them to consist of round, oval, and caudate nucleated cells, exactly resembling those found in cancer, and acting with acetic acid in the same manner. Yet the lining membrane of the bladder, the ureters, and kidneys, were perfectly healthy. We need not wonder, then, that epi-

thelial cells have frequently been mistaken for those of cancer, even by histologists; and that many growths, consisting of hypertrophy of the epidermis, or epithelium, as in several so-called cases of cancer of the lips, ulcerated warts, excrescences, &c., should have been mistaken for malignant growths.

Dr. Bennett states that he is not aware of any tissue in which a fibrous and a cell-structure, such as has been described, were combined; and he is, therefore, inclined to think that whenever we find cells of this kind deposited between the meshes of a filamentous structure, we may be satisfied that cancer is present. If we trust to the form of the cell alone, we may confound epithelial growths with cancer—if we trust to the fibrous elements alone, we may mistake sarcomatous growths for it. But in no case, so far as his experience has yet gone, can the two be associated without the existence of malignant growth. This character, then, he thinks one which will apply to all forms of cancer. In many cases the form and appearance of the cells, to an experienced eye, will be sufficient; this more especially when they are fully developed, and the influence of acetic acid upon them observed. In difficult cases the conjoined character of the cells and fibres, and their relative position with respect to each other, will enable us to determine the point with more exactitude. To arrive at a knowledge of these facts, however, considerable skill in the manipulation of the microscope is necessary, and a very intimate acquaintance with the healthy and morbid tissues of the body. To distinguish the relative situation of the cells and fibres, especially when mucous membranes are the object of investigation, a section, by means of Valentin's double-bladed knife, is also in most cases essential.—C.]

587. Another morbid production that has generally been classed among malignant growths, because it affects many textures and may supersede them, is *melanosis*, *black cancer*, or *black tubercle*. It most commonly occurs in the form of a loose cellular tissue filled with the peculiar black matter suspended in a serous liquid; but sometimes its substance is quite compact and resembles crude yellow tubercle, or the lardaceous form of cancer. I have a drawing which I made of a lung exhibiting a combination of encephaloid disease with melanotic tumors, the latter of compact texture, like nodules of pulmonary apoplexy, and varying in color from a dark bistre brown to a deep jet black. The combination of melanosis with carcinomatous tumors has also been noticed by Cruveilhier and Carswell. Andral describes melanosis to occur in four forms: "(1) It pretty frequently constitutes masses, encysted or otherwise; (2) the matter which composes it may, like the tubercular matter, be infiltrated into different tissues; (3) it may be spread like a layer, of greater or less thickness, on the free surface of membranous organs; (4) it may exist in the fluid state, either pure or mixed with other fluids."[1]

The peculiar characteristic of all these forms is the black matter, which, from the analyses of Dr. Fyfe, M. Thenard, and M. Foy, ap-

[1] Pathological Anatomy (Transl.), vol. i. p. 219.

pears to be a highly carbonized insoluble matter, supposed to be altered coloring matter of the blood. It has been compared by Andral to the black pigment of the eye, and he considers it to be identical with the black matter commonly found in the lungs and bronchial glands. The coloring matter of the blood certainly is sometimes changed into a perfectly black matter, as in the black vascular striæ and patches in the intestinal canal, particularly in chronic inflammation, where the blood has been effused or retained in vessels, and altered by the intestinal secretions and gases. These black appearances are called by Dr. Carswell spurious melanosis. Again, the black pulmonary matter is merely a carbonaceous powder contained in the interstices of the textures, and sometimes in the vessels of the lungs and bronchial glands; but whether it also proceeds from the coloring matter of the blood in an altered state, or is truly a deposit of carbon, is uncertain. All that is requisite to produce a black carbonaceous deposit in the coloring matter of the blood is the abstraction of a certain amount of hydrogen, which the mineral acids are capable of effecting ; and it seems not improbable that such a change takes place naturally in the formation of black pigment through the operation of peculiar cells (pigment cells), and as a result of disease in melanosis.

But this production of black matter may coexist with various modifications of the nutritive process; plastic, as in cellular and membranous melanose tumors ; cacoplastic, as in the hard black tubercle, and in the black consolidation of chronic pneumonia ; and aplastic, as in the combination of black with opaque caseous matter, not unfrequently found in the lungs and bronchial glands. So, too, it may be, as we have seen, combined with various forms of malignant disease ; but, with Andral, I hesitate to class simple melanosis with malignant growths.

588. The *treatment* of malignant disease has been generally considered to belong rather to surgery than to medicine, and yet the utility of removing malignant growths by operation, has been generally deprecated by surgeons down to the present time, when they may again learn, chiefly from the investigations of physicians, when and why operations may be expected to be successful. The indications of treatment which are suggested by the foregoing account of malignant disease, may be summed up under three: (1) to extirpate the malignant growth; (2) to retard its development; and (3) to counteract its effects.

The complete extirpation of malignant growths can be effected only when they are quite local, so that, when removed by the knife or by caustic, no root or stray germs of the disease shall be left behind. We have adduced reasons to suppose that, at its first origin, cancer is entirely local, and that, if it be completely excised at an early period, a cure may be effected. For this success, it is essential that every cancerous cell be removed; and Dr. Hodgkin has recommended the careful examination of the portion removed, to see that it contains on its surface none of those grains, consisting of an aggregation of cancerous cells, which can be seen, even with the naked eye, in cancerous structures. Dr. W. Budd recommends the use of the microscope for the same purpose : "If the characteristic cells were found on the cut surface

of the portion removed, it would be morally certain that others have been left behind, and that the extirpation is incomplete, although, on the other hand, the absence of these cells would be by no means so sure a guarantee of their entire removal. Such an examination would, however, always be a matter of great interest to the surgeon."[1] The best security would lie in the operation being performed before the constitution has been, in any degree, impaired by the disease; and particularly before any neighboring parts, especially lymphatic glands, have shown any indications of disease. The best chance will, therefore, be afforded in cases in which the growth is most chronic and inactive, and of the smallest extent, as in scirrhus of the lip, skin, or breast. If any cancerous texture or germs are left behind, the operation is likely to do harm instead of good, by bringing them into activity, and developing the acute form of the disease. Cases have occurred, in which a cancerous breast has been completely removed by a spontaneous sloughing; but such an event is extremely rare. Cauterization is less advisable than excision, because less manageable.

589. The second indication, to retard the development of the malignant growth, is chiefly to be attempted by means which diminish the circulation through the diseased part. Repeated local bleedings have been found useful, partly, perhaps, in this way, but more by relieving the inflammation excited by the growth. The best means of staying the growth of malignant disease is by pressure, which has long had many advocates. Such a kind and degree of pressure as will reduce the circulation through the part to the lowest degree compatible with its life, will pretty surely arrest the increase of the morbid growth, by depriving it of its nutriment. But, for the utility of this measure, it is equally necessary that the disease shall not have extended to other parts besides those to which the pressure is applied; otherwise, in those parts which are commonly internal, the growth will proceed with an increased rapidity, proportioned to its suspension by the pressure on the outward part. The best means of applying pressure are those contrived by Dr. Arnott, especially the slack air-cushion under a compress. It is very doubtful that we possess any means of influencing malignant growths through the constitution. Various medicines have enjoyed an ephemeral repute for their efficacy in cancer. Of these, conium has been one of the most favorite. Dr. A. T. Thomson considers the iodide of arsenic to possess some power in controlling the increase of cancer. But it is doubtful that any of these remedies do more than soothe irritation, and restrain common inflammation and its results, with which malignant growths are generally complicated.

[Dr. Bennett does not coincide in the opinion that cancer is necessarily fatal, because it is not easy to understand why nature should never cause the degeneration and disappearance of this one particular growth alone, whilst every other tissue and form of cell-life, was occasionally abortive. Cruveilhier, Trousseau, Hodgkin, and others, have frequently traced the conversion of scirrhus into ossiform matter, in the lower animals and in man. Dr. Bennett has seen this transformation in five

[1] Lancet, May, 1842.

cases, and he considers that they offer conclusive evidence that cancer is capable of undergoing the calcareous transformation. "It has been stated that cancer sometimes becomes transformed into fibrous or fatty tissue, and thus produces cicatrices in organs. It is very difficult to prove such a statement, because if there be no cancerous cells in a fibrous tissue, it is contended that it is not malignant, and never has been. On the other hand, if cancer-cells be present, it is clear that we have no evidence of degeneration. There can be no doubt that many organs and tumors are considered cancerous which are only fibrous. Dr. Bennett has examined many so-called cases of scirrhus of the pylorus, which were only hypertrophy of the muscular and fibrous tissue of the part. He alludes to a case of Dr. Alison's he had examined, in which the coats of the stomach throughout varied in thickness from an inch to an inch and a half. The viscus was thought by all who saw it to be cancerous, and yet he showed it to consist of nothing but fibrous tissue and fusiform cells. He had also proved many tumors supposed to be cancerous to be only fibrous. Professor Bochdalek, of Prague, formerly pathologist to the hospital there, and now professor of anatomy in the university, published a memoir in 1845, *On the Healing Process of Cancer in the Liver*. He describes the cancer in this organ as breaking down into a cream-like matter, the fluid parts being absorbed, and the whole shrinking together, forming a puckering on the surface, often corresponding to a fibrous mass or a fatty material, in which collapsed cancer-cells may yet be detected. In some livers he has seen these cicatrices in all stages of formation, cancer in some places, and perfect cicatrices in others. In Prague, he tells us, there are between 400 and 500 bodies examined annually. Among these, cancer of the liver occurs about 16 or 17 times, and among these, proofs of healing may be observed between 6 and 7. (*Oesterreichische Wochenschrift*, 26th April, 1845). Dr. Bennett has frequently seen these appearances in the liver, but he had never been able to satisfy himself that they were proofs of cured cancer. There are strong probabilities in its favor, however. Tubercular masses are rare in the liver of adults; and such lesions must depend either upon cancer or upon chronic abscesses.

Dr. Bennett considers that, taking every statement into consideration, it is by no means improbable that cancer might occasionally degenerate into a fibrous mass, although we still require positive proof of it. At all events, they have convinced him of the necessity of making farther researches on this subject. The same difficulties exist with respect to the supposed degeneration of cancer into fat. Nothing is more common than to find associated with cancer, a yellowish friable matter, more or less abundant, resembling cream in color or consistence, or presenting a bright gamboge yellow tint. This, on examination, is found to consist of numerous granules, which disappear on the addition of ether, and refract light like globules of oil. Whether these granules are elementary nuclei and cells, or whether they are the result of the disintegration of cells previously formed, is unknown.—C.]

590. The third indication, to counteract the effect of morbid growths, is more commonly the object of treatment; but the means of fulfilling it fail more and more as the disease advances. The use of narcotics of

every description,[1] general and local, to soothe the pain and irritation, and of occasional local antiphlogistic measures to remove inflammation and congestion, is commonly admitted in palliation of malignant disease; but the importance of tonics and nutritive diet to counteract the increasing cachexy and emaciation, is not so generally regarded. Yet these have appeared to me to have considerable efficacy in supporting the constitution, and supplying it with strength against the enemy that is preying on its vitals. Preparations of iron, when borne, are the best tonics. The remarkable absence of fat, in the textures wasted by prolonged cancerous disease, suggests the possible utility of cod-liver oil as a nutrient article.

SECTION IX.

DISORDERS OF MECHANISM.

591. Many structural diseases arise, from changes in the mechanism of organs, which are not precisely implied in any of the preceding elements. It is quite needless to enter into a detail of these alterations of mechanism; but to complete our key to the elements of disease it will suffice to cite a few examples.

Hollow organs are liable to *dilatation* from an undue accumulation of matter within them. Thus the heart, arteries, and veins, the air-cells of the lungs, portions of the intestinal tube, the bladder, &c, become distended when there is an obstruction to the passage of their respective contents, or when the expulsive power by which they are contracted is weakened; and such distension, if long continued or frequently repeated, becomes a permanent dilatation.

Parts may become overstretched and relaxed by a loss of natural cohesion or elasticity; thus, ligaments, tendons, and fasciæ become relaxed and ineffectual in binding together or connecting the parts to which they are attached.

592. *Contraction* is the opposite of dilatation. It may constitute *stricture*, and lead to the partial or total obstruction of parts of the canals of the intestines, urinary and respiratory apparatus, vascular systems, &c. The influence of contraction of the texture of organs and of serous membrane, we have several times had occasion to notice as the results of disease.

593. Parts may be *ruptured* or *lacerated*, either from previous disease or from violence, and structural disease is the result. Thus, hollow organs,

[1] In this, and other painful complaints, the acquisition of an effectual and harmless anodyne agent, is an inestimable boon to suffering humanity; and the discovery, by Professor Simpson, of the powerful anæsthetic influence of Chloroform, or terchloride of Formyle, promises to supply a most valuable addition to our materia medica. Hitherto, it has been used only (by inhalation of its vapor) to induce insensibility during painful operations, in the same manner as sulphuric ether (§ 128); but we may reasonably expect that an agent which, by its full influences, can destroy the most acute pains, may, by a moderate and more continued administration, permanently mitigate more constant sufferings. Probably, we may hereafter find this remedy available in the form of an *anodyne smelling-bottle*.

the heart, or arteries, the stomach, the gall-bladder, the urinary bladder, have been ruptured with speedily fatal results. Rupture of the valves of the heart, of portions of bloodvessels, of air-cells, &c., injures the mechanism of these parts and forms an element of structural disease.

594. *Displacements* and *compressions* of organs are frequently the effect of tumors or effusions, as in the case of the tumor of ascites, or ovarian dropsy, or an enlarged liver, pushing up the heart and lungs, and variously compressing and displacing the abdominal viscera; of an enlarged heart, or aneurism, displacing and compressing the lungs and air-tubes; effusions in a pleural sac, compressing the lung of that side, and displacing the heart, mediastinum, diaphragm, liver, and the walls of the chest.

595. *Contortion* of rigid parts is exemplified in rickets, mollities ossium, and rheumatic nodosities of the joints. Curvature of the spine, besides shortening the length of the trunk, disorders also the mechanism of respiration, by changing the position of the ribs; and when the distortion is great, the function of the heart and great arteries, and of the abdominal viscera, may be likewise affected by it.

CHAPTER V.

THE CLASSIFICATION, SYMPTOMS, AND DISTINCTION OF DISEASES.

SECTION I.

NOSOLOGY.

596. Having considered the causes of disease, their mode of operation, the resulting effects on function and structure in the ultimate and proximate elements of disease, and the remedial influences which can be brought to remove or counteract these elements; we have next to notice the manner in which these elements of disease affect the several parts and functions of the body, the symptoms which they induce, and the combination or forms which they present, as *special diseases*. In order thus to allot together in distinct divisions the wide domain of disease that has been displayed by general pathology, it is necessary to *define* special diseases; that is, to designate their peculiarities of situation, kind, and phenomena, by short descriptions, and to group and subdivide them in classes, orders, genera, and species. This classification and definition of diseases is usually implied by the word *Nosology*.

597. Diseases may be classed in different ways. The first method attempted was a classification according to their most prominent phenomena, or symptoms. Of this kind was the system of Sauvage, who divided diseases into ten classes: *Vitia*, *febres*, *phlegmasiæ*, *spasmi*, *anhelationes*, *debilitates*, *dolores*, *vesaniæ*, *fluxus*, *cachexiæ*. The classifications of Linnæus, Vogel, and Sagar were also of this kind, which may be termed artificial; and Cullen's division was a strained simplification of the same description of arrangement, condensing all diseases into the four classes—*pyrexiæ*, *neuroses*, *cachexiæ*, *and locales*.

The chief objection to this, which may be called *symptomatic nosology*, is, that it regards symptoms as the essence of diseases, whereas many symptoms are not essential, and those that more constantly occur are extremely variable, both in their kind and severity, and by no means uniformly correspond with the nature or with the amount of the real change of function and structure present. Hence, too, similar symptoms, from the most diverse causes, are classed together, although they may require quite opposite plans of treatment; whilst diseases that are really kindred in their nature, are widely separated, because they differ in their symptoms. The artificial method of classification is admissible

only as a provisional means of arranging subjects in a conventional way, until the true nature of these subjects is investigated; when this is done, or even as it advances, the artificial method should give place to the natural one, which is not a mere glossary of names (or symptoms), but in itself expresses the most important points of knowledge of the nature of the subject.

598. The true foundation of a natural classification of diseases is in a correct pathology, or knowledge of the intimate nature of diseases; but the subdivisions are conveniently determined by the chief seat of the disease, or by other of its more prominent characters. The classification of Pinel approaches to this standard, although it is necessarily imperfect from the infant state of pathology at his period. He divided diseases into five classes: *Fevers*, *inflammations*, *hemorrhages*, *neuroses*, *and organic affections*.

Pathology may be applied to the classification of diseases in two modes. In one, it is the first step in the arrangement, all diseases being distributed in classes expressive of the several pathological elements affecting the systems defined by general anatomy. Thus, according to the groups of pathological elements which we have reviewed, the *classes* might be: Diseases of the muscular system, those of the nervous system, of the secernent system, of the blood, of the vascular system, and of nutrition. The subdivision of these classes into *orders* would be determined by the individual pathological elements; thus, diseases of the muscular system would be divided into those of irritability and those of tonicity, with the *generic* subdivision according to excess, defect, or perversion; and, lastly, the *specific* distinctions would be made according to the organ or locality affected. This arrangement is not suitable for clinical or practical purposes, because diseases are generally too compound to admit of being classified according to their elements: they commonly comprise several pathological elements, and the proportions of these elements vary with the progress of the case.

599. The other mode of using pathology in nosology, is by making it subservient to establish those divisions or subdivisions in which the character of its elements affords an obvious and natural mean of distinction, which may be useful in the diagnosis and treatment of disease, whilst the remaining divisions are derived from the situation or other circumstances of the disease. Thus, diseases may be classed according to their chief locality, the organ or set of organs which they affect. Thus, as *classes* of disease, we may have, diseases of the *organs of respiration;* diseases of the *organs of circulation;* of the *apparatus of alimentation;* of that of *urinary excretion and of generation;* of the *nervous system;* of the *organs of locomotion;* of the *skin;* of the *blood;* and, lastly, *general diseases*, have no defined seat. The division of these classes into *orders* is founded on pathology; thus, each class comprehends *functional* diseases, subdivided into diseases of *irritability*, *tonicity*, *sensibility*, &c., and *secretion;* and *inflammatory* and *congestive diseases;* and diseases of *nutrition* (*structural*). A farther division into *genera* and *species* is made according to the anatomy of the parts: thus, of the class, *diseases of the organs of respiration;* order, *functional disorders;* genus, *irritability;* the species would be *spasm* and *paralysis*

of the larynx, *of the bronchi*, &c. But in general diseases, the subdivisions must be altogether pathological, or founded on causes or symptoms: thus, *fevers* are distinguished into *inflammatory*, *eruptive*, *adynamic*, or *contagious*, and *malarious*, or *intermittent*, and *continued*, as each of these modes of distinction becomes most available.

This last classification, although it may be less pure and methodical than others, is the most useful in practice, because it most closely follows nature; and, setting aside more minute and difficult distinctions, it leads to the seat and nature of the disease, and renders available those general principles in pathology and therapeutics which form the foundation of rational medicine. A chief recommendation of this kind of nosology, or arrangement of individual diseases, is, that whilst it includes all diseases hitherto distinguished, it points out others which may and do occur, but, for want of distinct pathological views and names, have been confounded with those more prominently defined.

600. The *definitions* by which individual diseases are designated, may refer either to the pathological nature of the disease, or to its characteristic symptoms, or to both; and, in some instances, the causes or results of the disease form a characteristic part of its history. It should be remembered that the great purpose of nosology is to arrange and define diseases in such a manner that their true nature, with the chief points of affinity and difference between each other, may be expressed by the arrangement and definition; and whether these points of affinity or difference are most manifest in the causes, nature, or symptoms of the diseases, the arrangement and definition should duly regard them. Thus, besides its chief peculiar symptoms, the definition of a distinctly infectious disease, as scarlatina, should express its infectious character; that of a disease indubitably caused by marsh miasmata, as ague, should imply this fact; whilst, both being classed as *general* diseases, and in the order *fevers*, the one of the genus *eruptive*, the other of the genus *intermittent*, much of the nature of the diseases, as well as of their distinguishing characters, will be set forth by this nosological arrangement. The farther that our knowledge of pathology is advanced, the more considerable a part will it form in our nosological systems; but, in the mean time, it is better to render our classification and definitions as useful as possible, by deriving them from *all* the most available sources of information, than to keep them imperfect and inapplicable until science is sufficiently advanced to supply us with a system that is quite pure.

As we do not enter upon *special pathology*, or the history of individual diseases, it is unnecessary to proceed into details of nosology. The foregoing remarks are intended merely to explain the objects of nosology, and to introduce the two associated subjects, *semeiology* and *diagnosis*.

SECTION II.

SEMEIOLOGY AND DIAGNOSIS.

601. *Semeiology* treats of *signs*,[1] and in medicine, of the *signs of disease*. The word *symptom* is commonly used in the same sense as *sign;* but, as its etymology implies,[2] it is a more vague expression, signifying *coincidence*, or *co-occurrence*, rather than a direct or constant connection. It has been attempted by some writers (particularly French), to restrict the word symptom to the phenomena manifested by present disease only; but this is contrary to the usual custom by which we speak of *precursory* and *consecutive symptoms*, *symptoms of health*, &c. Again, some have confined the term *symptom* to the phenomena depending on vital properties, whilst those phenomena of disease which are more directly physical, they call *signs*. This was the sense in which Laennec used these words, and others have followed his example. Although this acceptation of the words is not in strict accordance with former usage, or with their etymology, yet it would be convenient for conventional use; and, to render it more precise, it will be well to prefix the epithets *vital* and *physical*, as first suggested by Bayle, and partially adopted by Laennec.

Let us, then, understand the word *sign* of disease generally to imply anything by which the presence of disease may be made known. A *symptom* is any phenomenon which becomes obvious in the course of disease: it may thus often prove to be a sign; but many symptoms are of such uncertain connection with a particular disease, that they cannot be said to make known the presence of a disease; and, therefore, they cannot be called signs. The more specific designation of *physical signs* and *vital symptoms* will succeed better in attaching a distinct meaning to the different phenomena of disease; and, by stating briefly the grounds of this distinction and the proper application of the terms, we may be able to point out the respective value of each class of phenomena to which they are properly applied.

602. *Physical signs* are those physical properties of the body, or of a part of it, which are perceptible to any of the senses of the observer. Thus, the form, size, color, firmness or softness, weight, heat, and odor of the whole body, may be said to give physical signs or evidence of its condition, whether in health or in disease. So, also, the form, size, color, resistance, position, temperature, smell, and acoustic properties of a part of the body, afford physical signs of its condition, whether in health or in disease. Thus, the appearance of an external disease, the feeling of a solid tumor, or of the fluctuation of liquid in the abdomen, listening to sounds produced by or in diseased internal parts, furnish us with physical signs of the presence of disease.

[1] "*Sign*, that by which anything is known."—*Johnson's Dictionary.*

[2] *Συμπτπωμα*, from *συν*, with, and *π.πτο* or *πτοω*, to fall.

The difference between the signs of health and the signs of disease is determined by our knowledge of what is usual in health; and this knowledge may be derived (1) from general observation or experience of healthy standards, or (2) from anatomical and physiological knowledge of what the phenomena of health ought to be; or (3) from a particular knowledge of the standard of health in any individual case.

All of these healthy standards of comparison are available; the first is less exact than the other two; but it is often available for obvious disease. Thus, a jaundiced hue of the body, extreme pallor, or great emaciation, affords to the common observer physical signs of disease which cannot be mistaken. But slighter degrees of the same signs may become manifest only to those who, by previous acquaintance, know more exactly the standard of health in the individual, and can distinguish a change in color or in flesh from that standard. Again, in local disease: a large tumor or swelling in a part is a sign of disease obvious to every one; but a smaller or more deep-seated tumor may be discovered by those only who have an accurate knowledge of the healthy anatomy of the part, or by those who, by previous observation, have made themselves familiar with the shape and feel of the part in health.

603. Another standard available to distinguish the physical signs of disease from those of health is a comparison of parts that are naturally symmetrical. Thus, a slight swelling in one limb may be readily discovered by comparing it with the corresponding part of the opposite limb. A projection or contraction of one side of the chest may escape observation until the two sides are compared by inspection or by measurement, which will detect the difference between parts that are naturally alike. This standard of symmetrical comparison is applicable, not only to all external parts and organs of animal life, but also to some internal parts, which, although not strictly symmetrical, are so far equally distributed on the two sides as to give symmetrical properties to the exterior. Thus, the lungs, in health, fall so equally on both sides of the chest, that they give corresponding motion and acoustic properties to both; and percussion or respiration yields similar signs on both sides. So, when disease affects one side, it changes its physical signs, and their difference becomes obvious by comparison with the signs of the healthy side. A certain degree of uniformity also results from the position of the viscera in the abdomen, so that (making allowance for the greater bulk of the liver on the right side), any considerable difference in the shape or resistance of the two sides may be interpreted to be a sign of disease.

604. For organs which are not symmetrically placed, previous knowledge of their natural structure, position, and physical properties is necessary. Thus, we cannot know the physical signs of diseases of the heart and liver, without having a healthy standard to compare them with. This standard is soon supplied by the observation of the signs in health, and our knowledge of it may be much assisted by a familiar acquaintance with anatomy and physiology, which teach the healthy condition and functions. Thus, anatomy teaches us that the heart lies behind the lower half of the sternum and the adjoining parts of the cartilages of the left ribs from the third to the sixth; and physiology

makes us acquainted with its regular double sound heard in this region; these furnish a healthy standard; and when we compare it with a case in which the impulse of the heart is felt to beat over a much wider space, and the sounds are irregular, and masked by grating or blowing murmurs, we at once discern these phenomena to be signs of disease. Again, anatomy informs us that the liver in a healthy adult extends little, if at all, below the margins of the ribs on the right side; and the knowledge of this fact points out as a sign of disease such dulness on percussion and resistance to pressure below these ribs as arise from the liver reaching much below its usual situation. The knowledge of the healthy mechanism and functions of the apparatus of respiration, circulation, digestion, and excretion is in many respects necessary to enable us to distinguish the signs of disease from those of health; it will guide us to refer the signs to their true causes; and it may often suggest the particular signs which may be expected to arise from a particular lesion.

605. Physical signs are phenomena taking place in the body, in accordance with physical laws. It is, therefore, obvious that a knowledge of these laws, as well as of the mechanism of the body, will assist us to interpret these phenomena; to explain of what they are signs, how they are caused, the variations which they may present, and the best mode of appreciating them. Thus, an aneurism of the arch of the aorta may be chiefly detected and studied through the physical signs which it produces. It forms a tumor under or near the top of the sternum, pulsating in a distinct manner, and with a peculiar sound; this tumor may press on the air-tubes in such a way as to alter their shape, and, by partially obstructing the passage of the air through them, may also change the sound of breathing in a particular way; by compressing the veins, it may also throw their current into unusual sonorous vibration; or, by a more complete obstruction, it may cause the veins to swell in a remarkable degree above the tumor; by its enlargement, the aneurism encroaches on the lungs, the walls of the chest, the muscles, nerves, bones, ligaments, &c., in such a way as to alter their physical properties and positions, and thus to produce various physical signs. Now, all these physical signs are phenomena produced in the altered mechanism, according to certain laws; and it is plain that a knowledge of these laws must greatly assist us to understand the signs, and to trace them to their true causes. Nay, even the aneurismal tumor itself, in its production, increase, and intrinsic signs, can be rightly understood only through a knowledge of hydraulics and dynamics, in connection with the structure of the heart and arteries in health and disease.

606. *Vital symptoms* are those phenomena which depend on *vital* properties of a part or parts of the body. Thus irritability, tonicity, sensibility, excito-motion, secretion, and the more complex functions resulting from combinations of these elementary vital properties (§ 104), in a natural state, produce the symptoms of health; in an altered state, constitute the symptoms of disease. Hence vital symptoms have also been called *functional* symptoms, and *physiological;* but both these terms are objectionable, because both *function* and *physiology* relate

likewise to physical properties; and would, therefore, include physical signs.

Vital symptoms are often less confined to a part than physical signs; because vital properties of the whole system are in mutual connection; thus the irritability of the heart spreads its influence throughout the vascular system; the sensibility of one part affects the nervous centres, and may produce sympathetic symptoms in other parts (§ 156); disordered secretion has effects on other parts (§§ 162–7, &c.); so that vital symptoms are often generally distributed throughout the body. For this reason they have been sometimes called *general* symptoms, to distinguish them from physical signs, which are chiefly local; but this appellation is not exact, inasmuch as vital symptoms are sometimes entirely local; as in the case of pain, spasm, &c.; and we have already mentioned that physical signs are sometimes quite general throughout the body, as those of the yellowness of the whole surface in jaundice, the swelling of the body in dropsy, &c.

Vital symptoms are sometimes called *rational*, because (I presume) their connection with their cause is rather a matter of inference than of direct observation; but this is the most absurd term of all; for observation is necessary to teach us the value as much of symptoms as of physical signs; and physical signs are of little use without a proper exercise of reason upon them.

607. Vital symptoms may be exemplified in pain, uneasiness, altered and impaired sensations, which arise respectively from exalted, perverted, or defective sensibility (§§ 125–136) in spasm and paralysis, which proceed from excessive or defective contractility (§§ 110–118), or excito-motory power (§§ 139–154); in cough, which is caused by irritation, or undue excitability of the excito-motory nerves of the air-passages, and muscles of expiration; in vomiting, which depends on irritation or undue excitability of the stomach, and the excito-motory nerves sympathetically allied with it; in dyspnœa, which arises from a feeling of want of breath (§ 234); in fever, which comprises an accelerated pulse, hot skin, diminished secretions, &c. (§ 437).

Symptoms may farther be found in the state of the different bodily functions in which vital properties are concerned. Thus, the state of the pulse is an important source of symptoms; a frequent or a slow pulse indicates an increased or deficient excitement or irritability of the heart (§§ 113, 117); a strong or weak pulse implies an increased or diminished strength of the heart's contractions (§§ 112, 116). A hard or sharp pulse is, in part, dependent on an increased tonicity of the arteries (§ 121); whilst a soft, compressible, or liquid pulse, depends on a diminution of this property (§ 123). Irregularity in the rhythm of the pulse arises from an alteration in the vital property of irritability in the heart, commonly connected with loss of strength. These various conditions of the pulse are sometimes the result of various diseases directly affecting the vital properties of the heart and arteries themselves; but more commonly, they are induced by diseases of other parts sympathetically, or through the blood influencing these organs, as in inflammatory fever (§ 437). Thus, in diseases of the heart and arteries, the pulse has more

of the character of a physical sign; whilst in other disorders, it is rather a vital symptom, depending on farther vital properties.

The state of the skin is another source of symptoms, chiefly connected with the vital properties of the superficial vessels, and secernent apparatus, and of the general circulation. Thus, the heat and dryness of the skin in fever, arise from accelerated circulation with diminished perspiration. When the skin is cold, the circulation is weak; when warm, it is active; and the occasional occurrence of perspiration in both these conditions, shows that another vital property, that of secretion, is concerned in causing the symptoms dryness and moisture of the skin. The signs furnished by the skin are physical, so far as regards the condition of the skin itself; but they are vital symptoms in relation to the state of the circulation, of distant organs, or of the system at large.

Many important symptoms may be derived from the appearances of the tongue. These appearances, when arising from primary disease in the tongue itself, may be considered as physical signs of its condition. Thus, when the tongue is inflamed, it is first red and swollen, and afterwards becomes covered with a film or fur, which, separating in patches, leaves the surface red, and smoother than before. But in a great many diseases, the tongue becomes red, swollen, furred, or brown and dry, from causes acting through the system; and these secondary affections of the tongue constitute symptoms of these diseases. The connection between febrile and other general diseases, and the appearances which they produce in the tongue, is not well understood; but it probably depends on changes in the secretion of the mucous membrane covering the tongue and adjoining parts.

The alvine excretions furnish symptoms of great importance in various diseases. When excessive in quantity, liquidity, and frequency, they constitute diarrhœa, which may be primary—that is, a disease in itself (§ 374); or secondary, and, therefore, a symptom of disease, as in cholera and mucous enteritis. As a symptom, it presents farther varieties in its character, whether feculent, bilious, mucous, watery, &c.; and these varieties indicating respectively accumulation of feces, or excessive secretion of bile, or mucus, or watery fluid in the intestines. The opposite condition, that of costiveness, is also a disease itself, and an important symptom in many diseases, indicating defective peristaltic action, defective secretions, or both, in the intestinal tube. The quality of the evacuation supplies symptoms in regard to color, shape, odor, &c., which often lead to a knowledge of the nature of disorder in the alimentary canal or in the system. Thus clay-colored feces indicate defective secretion from the liver; those very dark in color may denote the presence of diseased bile, or altered blood; vermicular motions may indicate stricture, or contraction of the intestine, and so forth.

The urinary excretion is a valuable source of symptoms, not only of diseases of the parts connected with it, but of disorders of other organs, and of the whole system. Being the chief emunctory through which foreign effete and superfluous matters are eliminated from the blood (§ 254), it is continually exhibiting changes in quantity and quality, in color and specific gravity, in its sediments, and in the effect on it of different chemical reagents. All these changes furnish symptoms of

disease, several of which have been already noticed in connection with various pathological elements (§§ 167, 176, 249, 254, 255, 257, 260, 309, 384, 385, 448, &c.).

608. The foregoing examples of sources of symptoms are given merely to illustrate where and how symptoms are to be sought for; to complete the list, it would be necessary to notice every function of every part of the body, and the symptoms which they furnish, which would fill a considerable volume.

As a knowledge of the mechanism of organs, in health and in disease, and of the physical laws which operate in them, is the best aid to the study of physical signs, so an accurate acquaintance with the structure and functions of the healthy and diseased body, and with the vital laws which influence them, is the best guide to the knowledge and explanation of vital symptoms. These symptoms are often obscure and unintelligible, because physiology and pathology are imperfect; but, in proportion as these sciences are advanced, their application to semeiology and diagnosis will be more complete. In the mean time, much of our knowledge of symptoms rests chiefly on mere experience; and, until the results of experience can be arranged in a more scientific manner, they may be parcelled *numerically*, in order to approach their laws by empirical means. But to render this *statistical* or *numerical* method of studying symptoms at all safe, it is necessary that the number of observations should be very large, that they should be applied to similar cases, and that the majorities which establish the rule, should very greatly preponderate over the exceptions.

609. Physical signs and vital symptoms respectively have their value in making known the nature and extent of disease. Physical signs are more certain, because they appeal more directly from the seat of disease to the senses; depending on simpler and more constant causes, physical properties, they are more constant and less subject to variation than vital symptoms, which result from more complex, and, therefore, more variable vital properties. Thus, of the signs of inflammation, the redness, heat, and swelling are physical signs, and more certainly prove the existence of inflammation than does pain, which is a symptom depending on the vital property, sensibility, and which may be present where inflammation does not exist (§ 136), and may fail to occur when inflammation is present (§ 433). The physical signs of a structural disease in the lungs or heart, are better evidence of its existence, and of its nature, than cough, dyspnœa, pain, palpitation, &c.; because we know that these symptoms may arise from merely nervous or other causes, without the presence of any alteration of structure. Yet vital symptoms, although less sure and constant than physical signs, are often more delicate, being present before physical changes become appreciable; and when they coexist with visible signs, they indicate the nature and amount of disorder of the vital properties of the part, and of the whole system. Thus feelings of chilliness and discomfort, which usher in the fever accompanying tonsillitis, are sometimes present before the throat exhibits the physical signs of inflammation. A slight cough is often present in the early stage of phthisis, before the physical signs of tubercles can be distinguished.

Crepitation heard in the posterior regions of the chest is a physical sign of engorgement of the lung, with liquid in the minute tubes; but we must refer to the vital symptoms to determine whether the engorgement is inflammatory, or only congestive. The physical signs of consolidation of the lung, and of valvular disease of the heart, are very distinct; but, in order to determine whether these affections have arisen from present or recent inflammation, or are the results of old disease, it is necessary to consult the vital symptoms; and this determination is of great importance to the prognosis and treatment.

In short, it is obvious that both classes of signs ought to be carefully taken into account; and the more fully the physical and vital properties which constitute them are understood, the more available will signs and symptoms be, to instruct us as to the nature and treatment of disease.

610. Besides into physical and vital, various divisions of symptoms have been made; but they are of little real utility, and it is unnecessary to do more than enumerate them. Symptoms are *local*, or *general*, or *constitutional*, according to whether they are confined to the diseased part, or affect more or less the whole system. Symptoms are *idiopathic*, when directly proceeding from a primary disease; they are *sympathetic*, or *secondary*, when arising from secondary disorders, or those produced by the primary disease. *Premonitory* or *precursory* symptoms are those which precede the full development of disease, and commonly result from the first operation of its cause; hence they are called *symptomata causæ*. *Commemorative* symptoms are those developed in the previous history of the disease. *Anamnæstic* are those which relate to the previous state of health. Signs have been divided into *objective*, those which present themselves to the scrutiny of the practitioner; and the *subjective*, those described by the patient himself. The objective have been farther divided into the *active*, or *dynamical*, those that require some action, motion, or manipulation to discover them; and the *passive*, or *statical*, those that are obvious without such action. Symptoms are designated by the epithets *diagnostic*, *prognostic*, and *therapeutic*, when they are specially applicable respectively to the distinction, the determination of the event, and the suggestion of the treatment of disease. Symptoms are *positive*, when they consist of phenomena actually present; *negative*, when they consist in the absence of phenomena. Of diagnostic symptoms, those are called *pathognomonic*, or *pathognostic*, which are peculiar to one disease. A single symptom or sign is rarely, if ever, pathognomonic; but two or three taken together often are so.

[Some of the more important general signs of disease will be now enumerated. In the study of semeiology, several methods have been pursued. The one most useful, and most generally practical is, probably, that compounded of the *topographical* method, in which the symptoms presented by each portion of the body are treated of successively;—and the *physiological* method, which studies each apparatus of organs and functions, approximating those which offer most relation and analogy, thus grouping, in a natural way, the various

symptoms which the case presents. Accordingly, after an exposition of the signs derived from the external exploration of the patient—commencing with the body as a whole, with reference to attitude, configuration, and volume, and then passing to the consideration of the signs furnished by each region of the body respectively—we shall detail the symptoms and signs supplied by each of the great functions—as the nervous, respiratory, circulatory, &c. (§ 615.)

I. The symptoms presented by the exterior of the body, are of the greatest importance. By a first glance at the general aspect of the patient—*a coup d'œil d'ensemble*—the experienced physician, of quick perception and tact, derives most valuable information, and often recognizes the nature of the disease, and ascertains the actual condition of the patient. Many diseases, indeed, have their own special physiognomy, which is readily recognized by the initiated. "Medical physiognomy," it has been well observed, "is, in many diseases, a source of diagnosis which seldom fails the practitioner who is intimately versed in it; and we believe that much of that exquisite tact in the discrimination of disease which distinguishes some practitioners, and which others can never attain, depends on the vivid perceptions of an eye and ear habitually familiar with the lineaments, the tone, and the gestures of disease."[1]

The position and movements of the body and limbs, and the constitutional peculiarities and physiognomy of the patient, are of importance in a correct diagnosis.

The *attitude* varies more or less in disease. There may be an unusual degree of languor, as in the invasion of most acute diseases, or in the course of chronic ones; or the bearing may be unnaturally bold and assured, as in insanity or acute delirium. There are some diseases which may be at once recognized from the position of the patient; as catalepsy, from general immobility; chorea, from irregular and perpetual movement; hemiplegia, from distortion of the features, and altered position and impaired motion of the limbs; and tetanus, from the condition of the trunk.

The signs furnished by *decubitus*, or *decumbence*—the posture of lying—are often of value. In health, the position in sleep is on either side, perhaps oftener on the right, the body and limbs semiflexed, and the head bent towards the chest. A departure from healthy decumbence is noticeable in most diseases. When it is constantly *dorsal*, it is a token of extreme debility; of loss of motion, or of some affection in which movement is accompanied with severe pain. Hence we meet with it in all diseases attended with great prostration; in cerebral apoplexy, and in organic diseases of the brain and spinal marrow; in acute peritonitis; and, in general, articular rheumatism. The decumbence is *prone* in gastric, intestinal, hepatic, and renal colic, though generally not lasting; the patient frequently changing his position. It is *lateral* in certain affections of the chest, as pleurisy or pneumonia, or rather, in certain stages of those affections. No general rule can be given as to the position in bed of patients suffering under inflammation

[1] British and Foreign Medical Review, July, 1841, p. 108.

of the pleura or lung. It is very variable; sometimes on the affected, sometimes on the sound side; but, more frequently, if the effusion or hepatization be considerable, on the back. In double pleurisy or pneumonia, it is probably always dorsal. In pulmonary tuberculosis, where one lung only is affected, the patient lies by preference on the diseased side.

The *sitting* posture is generally assumed in certain affections of the thoracic viscera, which interfere with respiration, and cause orthopnœa —diseases of the heart, and arch of the aorta, acute phthisis, pneumothorax, hydrothorax, emphysema of the lungs, nervous asthma, etc. In this position, the body is usually inclined forwards, with the elbows resting on the knees; or some firm object is grasped by the hands, to fix the shoulders, and allow the respiratory muscles to act to greater advantage. In some affections of the abdomen, in which the cavity of the chest is invaded, and respiration impeded, the patient is obliged to be propped up in bed, or maintain the sitting position.

In laryngeal and tracheal disease, or where these organs are compressed by a tumor, the head is usually thrown back, whether the attitude be that of standing, sitting, or lying.

Persistence in the same position is usually a symptom of organic disease of the brain, or of idiocy.

Restlessness, jactitation, or constant change of position, occurs at the invasion of acute inflammations, and the idiopathic fevers, and in many of the affections of children; and frequently accompanies delirium and acute mania.

The *volume* of the body may be augmented or diminished. A slight and transient increase of size occurs in the commencement of inflammatory affections, and marked general tumidity of the body at the invasion of the exanthemata. An accumulation of fat is rarely a sign of disease, but may, when excessive, constitute a disease in itself—*polysarcia*. General enlargement of the body may proceed from *anasarca*, or dropsy of the cellular tissue, or from cellular emphysema, caused by a penetrating wound of the chest. Emphysema may be distinguished from anasarca by its not pitting on pressure; by its elastic feel, and by the sensation of crepitation which it gives. When the cellular infiltration is partial, it is termed *œdema*. Œdematous swelling may be more easily recognized when the disposition of the skin allows us to pinch it between the fingers. Incipient œdema may be often thus distinguished in patients confined to their beds, in the internal surface of the thighs (Chomel). In those who are up, œdema first shows itself around the malleoli, particularly towards evening.

Diminution in the size of the body is a frequent phenomenon in disease. It may occur with great rapidity, and to a considerable degree after excessive alvine discharges, as in serous diarrhœa, and Asiatic cholera. It is said to take place, in the same manner, after one or two paroxysms of malignant intermittent. It generally occurs more slowly, constituting *emaciation*. Emaciation is a much more frequent consequence of disease than obesity. It attends most chronic diseases; and is often among the first symptoms of phthisis. The emaciation of special parts of the body is observed in some maladies.

In disease of the liver and spleen, the face and extremities first waste; in tubercular phthisis, the upper extremities and clavicular regions.

II. The signs furnished by the head, face, and neck present numerous points of value.

The head is bent to one side in convulsions, hemiplegia, torticollis, dislocation of the cervical vertebræ, cervical glandular swellings, and large cicatrices of the neck, following burns. In vertebral malformation, it is bent forward. It is bent backwards in diseases accompanied with dyspnœa; as croup, laryngismus stridulus, suffocative catarrh, etc.; as well as in tetanus, and spinal meningitis of the cervical portion of the cord. The size of the cranium is increased in chronic hydrocephalus, and hypertrophy of the brain. The hairy scalp becomes œdematous in erysipelas, with extreme sensibility on pressure. It is sometimes enormously swollen in smallpox.

The *physiognomy* presents numerous shades of expression in the sick. It may appear sad, dejected, uneasy, terrified, indifferent, or attentive; sometimes smiling, at others menacing, or wandering, without there being any circumstance to account for these modifications of the features; which, consequently, should be classed among morbid phenomena (Chomel). Among the changes of countenance noticeable in disease, are the following: The *facies stupida*, distinguished by the great dulness of expression, particularly of the eyes, the patient appearing as if intoxicated. This is the physiognomy of a patient with typhoid fever. The *facies vultuosa*, characterized by fulness and redness of the face, prominence of the eyes, injection of the conjunctiva, distension of the eyelids and lips. It is met with in cardiac hypertrophy, and in cerebral congestion. The *pinched* countenance presents the opposite conditions, the face being apparently diminished in size from contraction of the features, and of a pale or livid hue. It is seen in acute peritonitis, and in healthy persons who have been long exposed to severe cold. The *facies hippocratica* is thus described by Hippocrates: The nose is sharp, the eyebrows knitted, the eyes hollow and sunken, the ears cold, contracted, and thin, and the lobes shrivelled; the skin about the forehead is hard, tense, and dry; and the face pale, or of a greenish, livid, or leaden hue. It occurs in chronic disease immediately before death, and in acute disease which has been unusually prolonged.

Dr. Siebert distinguishes six groups of physiognomical rugæ. The *R. Transversæ*, situate in the forehead, formed by the frontal muscle, express excessive pain arising externally. The *R. oculo-frontales*, extending from the forehead vertically to the root of the nose, express distress, anxiety, anguish, and severe internal pain. They also indicate in acute diseases an imperfect or false crisis, an impending efflorescence, and often a fatal termination. In severe headache, both the classes of rugæ just mentioned are observed. When the former join the latter abruptly in a disease, paralysis is impending or commencing. The *linea oculo-zygomatica* (of Jadelot), extending from the inner angle of the eye somewhat below the cheek-bone, indicates in children a cerebral or nervous affection; in adults, disorder or abuse of the genera-

tive organs. The *linea nasalis* of Jadelot and De Salle (the *Rhinal-linea orbicularis* of K. H. Baumgärtner) begins at the upper border of the ala nasi, and extends more or less curved to the outer margin of the orbicularis oris. It is strongly marked in phthisis and atrophy. The inferior portion (*linea buccalis*) indicates gastric disease; the upper portion (the proper *linea nasalis*), marks an affection of the upper part of the intestinal canal. Occurring conjointly with retraction of the cheek and with the *L. oculo-zygomatica*, the eyes being fixed and the complexion wan, it is a certain indication, according to Pieper, of worms. The *L. labialis* extends from the angle of the mouth, and is lost in the lower part of the face. In children, it generally marks a thoracic affection, which renders the respiration laborious or painful. The *L. collateralis nasi* passes downwards in a semicircular direction towards the chin, and externally to the *linea nasalis*, *buccalis*, and *labialis*. It generally indicates chronic and obstinate disease of the thoracic or abdominal viscera.[1]

Many of the specific forms of disease have their specific physiognomy. Children of a scrofulous constitution have either a delicate velvety skin, brown complexion, dark hair, with dark and brilliant eyes, and long lashes, with the lineaments of the face finely drawn and expressive; or, a fair complexion, thick and swollen nose, broad chin, irregular teeth, late developed, and early becoming yellow and carious, with inflammation of the Meibomian glands, scrofulous ophthalmia, intolerance of light, eruptions on the head, nose, and lips, and enlarged cervical glands.

Œdema of the face and eyelids is sometimes met with in anæmia, but very frequently is symptomatic of albuminuria.

Transient general *redness*, or flushing of the face, is common in women suffering from menstrual irregularity, and at the critical period of life. The bright circumscribed redness of the malar regions, with paleness of the rest of the face, known as the "hectic flush," occurs in wasting chronic affections, and particularly in phthisis pulmonalis. When it is limited to one cheek, the corresponding lung has been thought to be the affected one. This certainly is by no means general; but Dr. Stillé mentions a case observed by him. The same opinion has been entertained with regard to the livid red patches in the same region in acute pneumonia; but the researches of Grisolle do not countenance it.

Paleness of the face happens in the cold stage of fevers, and acute inflammations; in the hemorrhages; in chronic diseases, particularly Bright's disease; and in convalescence. The complexion of persons long deprived of a due amount of light, is unusually pale. The hue of the complexion of anemic patients is that of imperfectly bleached wax, or of a dingy white with a shade of green. A general yellow tint of the face is characteristic of jaundice. Sometimes, in slight hepatic derangement, the yellowness is limited to the labial commissures and alæ nasi. A citron tint is constant in cancerous affections; and a peculiar dingy light straw-color hue is met with in the inhabitants of malarious

[1] Technitt der Medicinisehen Diagnostik. B. and F. Medical Review, vol. xx.

districts. A bluish hue of the face, and skin generally, is indicative of impeded venous circulation; it is met with in asphyxia, from whatever cause; in Asiatic cholera; in typhus fever; and particularly in cyanosis (§ 238), and hence is often called the cyanotic hue. It partially disappears on pressure to return slowly. A permanent and deeper discoloration, amounting to slate color, is met with in persons who have been long subjected to the internal administration of nitrate of silver. It is indelible.

Perpetual motion of the eyelids is noticed in some cases of mania and idiocy. In adynamic fevers, they are sluggish and heavy. In photophobia, they resist any attempt to open them. They remain open when the portio dura has been injured, in consequence of paralysis of the orbicularis. When there is lesion of the third pair of nerves, the upper lid is paralyzed. *Epiphora*, or the flowing of the tears over the cheek, is caused by obstruction of the lachrymal duct; it occurs in the initial stage of ophthalmia, and in some neuralgic affections of the eye; and may be produced by the presence of a foreign body.

The nostrils dilate forcibly and rapidly in difficult respiration. Itching of the nostrils in children, is commonly regarded as a sign of intestinal worms.

III. The *throat* becomes enlarged in some anginose affections, in the first months of pregnancy, and at the approach of puberty in the female. The carotid arteries pulsate violently in acute mania, cerebral inflammation, hypertrophy of the heart with dilatation of the right ventricle, in anæmia, and sometimes in typhoid fever. Habitual fulness of the jugular veins occurs in connection with some impediment to the circulation. Pulsation of the veins of the neck, and particularly of the jugular—called the *venous pulse*—is caused, according to the researches of Dr. Beau, by contraction of the right auriculo-ventricular orifice—whilst by others it is attributed to patency of the tricuspid valves. Mr. Sibson has judiciously analyzed the influence of the heart's action, and of respiration on jugular pulsation.[1] The mere existence of such pulsation, he concludes, is anything but an indication of disease, either in the pulmonary valves or elsewhere. In diseases attended with impeded flow of blood through the lungs and heart, the jugular veins contain more blood, and their pulsations are visible; but when the impediment is extreme, the veins are in a state of constant distension, and no pulsation is visible. The pulsation of the arteria innominata—which lies in front and rather to the right of the trachea, just above the sternum—is seen in aortic regurgitation. Various circumscribed swellings are noticed about the throat and neck, which are due to glandular enlargements; as the thyroid gland, anteriorly and inferiorly, constituting goitre; the parotid gland in the lateral superior region; scrofulous lymphatic glands in the same situation; and the maxillary glands beneath the lower maxillary.

IV. Various deviations from the natural configuration of the chest

[1] Transactions of the Provincial Medical and Surgical Association, vol. xii. p. 307.

may depend on malformation of the spinal column, natural or acquired. But independent of deformity from this cause, the thorax may present certain modifications in form of semeiological value. A healthy well-formed chest is nearly symmetrical, the two sides corresponding in shape and size; but, though there is no visible inequality of size, the semicircular measurement of the right side of the chest, at the base of the lung, exceeds, in adult persons, that of the left; a condition due probably to the influence of excess of muscular exertion on the right side; for Dr. Walshe states, that in left-handed persons the left side sometimes measures more, or more frequently the same as the right. It is in form a cone, with its narrow end uppermost; its transverse diameter is evidently greater than its posterior; the post-clavicular regions are slightly depressed; the lower sternal region is concave in proportion to the development of the individual; the infra-clavicular regions are gently convex; the intercostal spaces are visible in inspiration and respiration, except in very fat persons; the lateral portions of the chest are equidistant from the median line; so also the nipples, which should be both on the same line; there should be neither anterior, posterior, nor lateral deviation of the spinal column; and the vertebral sulcus, moderately convex from above downwards, is more or less deep as the subject is fat or lean.[1] But it is common to meet with certain deviations in form, congenital and acquired, perfectly compatible with health. General prominence or *expansion* of one side of the thorax is usually caused by a large pleuritic effusion. It is most common on the left side. Local expansion, or *bulging*, is a consequence of several pathological conditions. When its seat corresponds to the base of either lung, it is caused by a gravitating pleuritic effusion; when situated at the anterior superior parts of the chest, by emphysema; when in the right hypochondrium, by enlargement of the liver; and when in the præcordial region, by effusion into the pericardium, or by hypertrophy of the heart. In aneurism of the ascending aorta, when advanced, a tumor is visible about the junction of the third rib with the right side of the sternum; whilst aneurism of the descending aorta makes its appearance between the base of the scapula and the spine. According to Dr. Chambers, one of the earliest physical signs of phthisis is a slight bulging of the anterior and superior regions of the chest.

Retraction of one side of the chest, most usually the left, is met with at the period of absorption of general pleuritic effusion. Long-continued pressure having reduced the volume of the lung, when the effused fluid—the compressing material—has been removed, the lung not recovering its original size, the chest yields to atmospheric pressure.

Depression, or local retraction, is met with at the period of absorption of circumscribed pleuritic effusion, and in pulmonary tuberculosis. Flattening and even depression of the infra-clavicular, post-clavicular, and upper scapular regions, occur in many cases of phthisis.

By inspection of the chest, the mode of respiration in the patient is ascertained. The number of respirations in a healthy male adult

[1] Williams and Clymer, Diseases of Respiratory Organs, p. 24.

generally ranges about twenty in a minute. It is more in females and in children. The act of breathing is accompanied, in health, by regular motions of expansion and elevation of the chest. These are *increased* in spasmodic asthma, and in all affections where dyspnœa is a prominent symptom. They are *diminished*, where there is an instinctive avoidance of pain, as in pleurisy and pleurodynia; in paralysis of the respiratory muscles; and when there is a material obstacle in the condition of the pleura or lung, as pneumonia, emphysema, pneumothorax, phthisis, &c. They are *jerking* when there is irregularity of muscular efforts, as in spasmodic asthma, obstructive diseases of the larynx and trachea, and pleurodynia. Respiration is *quick* when the movements of inspiration and expiration are performed with more than natural rapidity; it is *slow* when the contrary condition obtains. In natural breathing, the diaphragm concurs. When this muscle remains at rest, in abdominal inflammations and diaphragmatic pleurisy, and the act of inspiration and respiration is chiefly performed by the ribs, the respiration is said to be *costal*, or *high*. When, on the other hand, the action of the ribs is diminished, and that of the diaphragm becomes increased, causing the rise and fall of the abdomen, the respiration is called *abdominal*.

V. The *abdomen*, in health, is firm and pliant, moderately resonant, and varies in size in different individuals. In women who have borne children, and in both sexes where there has been abdominal distension, from ascites or other causes, white lineal marks, resembling cicatrices, will be found in the hypogastric region. In pregnancy, a brownish discoloration, situated on the median line, and extending from the pubis to the umbilicus, is often visible.

The *volume* of the abdomen may be *increased* generally or partially. When general, it is owing to the presence of fluid in the cavity of the peritoneum, or to gaseous distension of the intestines. When the distension from this latter cause is moderate, it is called *meteorism;* when excessive, *tympanites.* Different degrees of resonance accompany these symptoms; and the abdomen is elastic and resisting to the touch. They occur in adynamic diseases, peritonitis, intestinal obstruction, hysteria, &c. Local or regional enlargement of the abdomen takes place in the hypochondriac regions in diseases of the liver and spleen; in the epigastrium, in hysteria and cancer of the stomach; in the hypogastrium, in distension of the bladder, ovarian tumors, fecal accumulation, and the various varieties of abdominal tumors.

Diminution in the size of the abdomen happens in most chronic diseases, unless accompanied by ascites, or there exists an abdominal tumor. In chronic dysentery, there is extreme retraction of the parietes; and also in lead colic, in which the muscles are exceedingly hard and unyielding.

VI. The external exploration of the *genital organs* in the two sexes furnishes several important symptoms. The penis is enlarged in children suffering from vesical calculus, and who are addicted to masturbation. A cartilaginous hardness of the corpora cavernosa is said to occur in those who practice onanism. Retraction of the testicles happens in renal calculus. The scrotum is distended in hydrocele, hematocele,

and sarcocele. The labia majora are enlarged in general dropsy, and in certain local affections.

VII. The *extremities* become immovable in paralysis, and contracted and rigid in softening of the brain, and in other organic diseases of that organ. They become œdematous when their chief vessels and nerves are pressed upon, and their circulation embarrassed. The articulations become swollen in rheumatism, hydrarthrosis, white swelling, &c. The limbs are diminished in size in paralysis (§ 534).

We shall now proceed to consider the semeiology of the various functions.

VIII. The signs furnished by the nervous system in disease are of great value. We shall begin with the modifications of general sensibility or common sensation (§§ 132, 133).

Sensation is morbidly augmented in acute inflammatory affections of the brain and spinal marrow; in the idiopathic fevers in hysteria; and the so-called magnetic condition. *Pain* is at once an exaltation and perversion of sensibility, and is better understood than defined. There are several varieties of pain: 1. *Tensive*, with a feeling of distension, and is felt whenever parts are put on the stretch. It occurs especially in phlegmonous inflammation, and is generally accompanied with throbbing. 2. *Dull*, or *heavy*, when accompanied by a feeling of weight; it is experienced when there is enlargement of some of the viscera, an internal tumor, or effusion into the serous cavities. It is felt in the loins previously to menstrual and hemorrhoidal discharges. 3. *Smarting*, when the skin has been deprived of its cuticle; or when some irritant has been applied to the unprotected skin. 4. *Lancinating*, characterized by sharp, pungent, transient darting; and occurs in cancer and neuralgia. 5. *Boring*, resembling the sensation which a wimble or screw would produce in entering and turning on itself in the suffering part; and accompanies constitutional syphilis, rheumatism, gout, inflammation of the periosteum, &c. 6. *Burning*, felt in burns and scalds, and in anthrax, and in gangrenous erysipelas. 7. *Contusive*, similar to that felt after extensive bruises, and is a constant prodromic phenomenon in acute diseases. 8. *Tearing*, or *pungent*, compared to the sensation produced by opening the lips of a wound; 9, and finally, pain may be *special* in its character, as that experienced in hemicrania; during labor, or an amputation; or from a blow upon a superficial nerve, as the cubital, at the elbow. *Itching* is a peculiar exaltation and modification of sensation, seated in the skin, occurring principally in cutaneous affections. *Formication* is another perversion of the sensibility of the skin, and is so called from its resemblance to the feeling produced by the crawling of innumerable ants over the body.

Common sensibility may be *diminished* or *abolished*, the latter constituting *anæsthesia*. Diminution or loss of sensibility may be general or local; it may or may not be accompanied by diminution or loss of motion; and it may be organic or functional.

The *special senses* may be *exalted*, *impaired*, or *perverted*. Exaltation of *vision* occurs in ophthalmia and inflammation of the brain and its me-

ninges, and some nervous affections. This sense is diminished in many diseases, and totally abolished in some affections of the eye and brain. It is variously perverted in a number of maladies. Objects having no existence being procured, as sparks or flashes of light, floating specks (*muscæ volitantes*), or dark waving lines, and connect with affections of the brain and optic nerve, as well as in dyspepsia; or the proper hue of objects may be changed; or one-half only of the object looked at may be visible (*hemiopsia*); or it may seem double (*diplopia*).

The *hearing* is often painfully acute in cerebral inflammations, and in hysteria; it is obtuse in typhus fever; and may be impaired or entirely lost in certain affections of the organ of hearing. It may be perverted in two ways; unreal sounds may be heard, as ringing of bells, buzzing, falling of water, noise of wind, &c.; or sounds which are actually heard, are not appreciated or recognized.

Smell may be exalted, diminished, and perverted.

Taste is rarely augmented in disease, but very commonly impaired in acute disease, totally lost at the close of severe affections, and variously perverted in numerous instances.

The power of voluntary motion, or *motility*, may be increased, diminished, abolished, or perverted (§§ 140, 141, 142).

Increase of muscular strength takes place sometimes in the course of acute disorders accompanied by delirium, in cerebral inflammation, and in mania. *Muscular debility* attends most diseases, and may depend on a variety of causes, organic and functional. Complete abolition of voluntary motion constitutes *paralysis*. It may be indicative of lesion of the brain or of the spinal marrow, as apoplexy, spinal softening &c., or of injury to a nervous trunk; or it may be only functional, as happens in some cases of hysteria. It may be partial or general: if it affect one side of the body it is called *hemiplegia;* if the lower half of the body, *paraplegia*. *Perversions* of *motility* consist: 1, in *trembling*—a feeble involuntary agitation of the muscles involved—and occurs in the cold stage of fevers, in nervous affections, ataxic fevers, and in old persons; it is caused, too, by the action of lead and mercury on the system, and by the prolonged use of strong coffee, alcoholic liquors, tobacco, and opium; 2, *rigidity*, in which there is diminution of muscular power, and gradual rigid contraction of the flexor muscles of the limbs. Rigidity of the upper extremities is a symptom of softening of the brain. This symptom occurs too in cerebral extravasation, and in hysteria.

The *reflex* or *excito-motory* system furnishes numerous symptoms of value. Its functions are *exalted* and *perverted* in *spasm* or *convulsions*, which may be *tonic* or *permanent*, or *clonic* or *transitory*.

Cramp is a variety of tonic spasm, and consists in a sudden but permanent contraction of one or more muscles, accompanied by hardness of the tissue and numbness, and inability to execute any movement of the affected part. The muscles of the calf of the leg and of the abdomen, are its chief seat. Pregnant women suffer especially from it, as well as those in whom an ovarian tumor may exist. It accompanies hysteria and painters' colic. When it occurs in old persons it is said to betoken cerebral softening. Many persons in health suffer from it.

Tetanus is another form of tonic spasm. Muscular contraction here, is equal and permanent, the affected muscles being in a state of absolute immobility, which no internal or external effort can overcome. When the muscles of mastication only are affected, it is called *trismus;* if the anterior muscles of the body, causing flexion, or curvature of the head and trunk forwards, *emprosthotonos;* if the posterior muscles, bending the body backwards, *opisthotonos;* or if the muscles of one side contract more powerfully than those of the other, so that the curvature is lateral, *pleurosthotonos.*

In *catalepsy*, the flexor and extensor muscles are in a state of permanent contraction, and the part implicated retains, during the whole attack, the position that it assumed at the moment of seizure, no matter how uncomfortable that may be.

Clonic spasm, in which contraction and relaxation rapidly alternate, is seen in *convulsions* occurring in children, hysterical females, and in some affections of the brain; and in *subsultus tendinum*, an involuntary and instantaneous twitching of the muscles, taking place in acute diseases of an ataxic form, more observable at the wrist than elsewhere. *Hiccough* is probably involuntary reflex contraction of the diaphragm. Defective reflex or excito-motory action is seen in paralysis of the sphincters, respiratory muscles, &c. (§ 154.)

Morbid rhythmical movements of different parts of the body—as bowing movements of the trunk, rotatory movements of the head, vibration of a single limb, and other anomalous motions—are sometimes noticed, and are considered by Dr. Paget to arise from disease of the cerebellum, or its commissures.[1]

Reflected or *sympathetic* sensations, where the impression made at one point is felt in another, as the pain at the extremity of the penis, due to calculus of the bladder, and other well-known instances, have been already mentioned (§ 156).

The affective, perceptive, and intellectual faculties are variously affected in disease. More or less mental dejection, disquietude, and impatience are always manifested.

The affective functions may be *exalted* in hypochondriasis, the patient being readily excited to strong hatred or profound friendship, or readily moved to tears on the expression of good-will towards him, and as easily aroused to suspicion and dislike. Moral sensibility is, on the other hand, sometimes totally *abolished* in mania and typhus fever, perfect indifference to self, and to those about the patient, being manifested. *Perversion* of the character and affections is sometimes met with in disease; amiable persons becoming irritable and peevish; the brave, timid; and the pusillanimous, resolute.

Perversion of the perceptive faculties accompanies commonly insanity, and consists in *illusion* and *hallucination.*

Exaltation of the intellectual functions is often a prominent symptom in melancholia, and sometimes occurs at the close of life, particularly in acute affections. *Diminished* or *enfeebled* action of these faculties is more common in disease than the opposite condition. It constantly

[1] Edinburgh Medical and Surgical Journal, Jan. 1847.

occurs in typhus fever. Perversion of the intellect constitutes *delirium.* Delirium is more common in the affections of infancy and youth, and in individuals of great nervous susceptibility. It is met with in diseases of the brain and its meninges, and in typhus fever, the exanthemata, and diseases of the chest and abdomen, as a sympathetic affection. It may be furious, mild, taciturn, or loquacious; and may be constant or transient; in the latter case, it may recur at regular intervals.

The symptoms furnished by *sleep*, are complete suspension of sleep (*insomnia*); *somnolency*, or *drowsiness*, noticed in typhoid fever, and some cerebral affections; *coma*, of which there are two varieties: 1. *Coma vigil*, accompanied by delirium, muttering, and jactitation, the eyes being closed, except when the patient is spoken to: 2. *Coma somnolentum*, in which the patient speaks only when aroused; *lethargy*, a constant and more profound sleep, from which the patient may with difficulty be aroused, but seems unconscious, and speedily relapses; and *carus*, or total insensibility.

The *voice* rarely becomes stronger in disease, but may in delirium. In most maladies it is weaker, especially in those of the vocal and respiratory organs. It may be entirely lost, constituting *aphonia;* or become *hoarse*, as in angina of the throat; or *shrill*, or *whistling*, or *nasal.*

The *speech* is often affected in disease. It is *trembling* in some maladies, and slow or difficult in others, as typhus fever. *Stammering*, or defective articulation, occurs in fevers and cerebral affections.

IX. The semeiology of the *respiratory organs* is so vast and important, as to demand for its appropriate treatment a separate chapter. An outline only will be given here.

Amongst the so-called vital symptoms (§ 606), dyspnœa, cough, and expectoration may be enumerated.

Dyspnœa, or difficult or disordered breathing, is a symptom of great importance in affections of the lungs, and demanding every attention. It may be due to the causes, which, when excessive, produce asphyxia (§§ 134, 135, 136). The subjoined tabular view, by the author, of the causes of dyspnœa, showing the varied nature and origin of the symptoms and diseases it is met with in, is taken from another work.[1]

PROXIMATE CAUSES OF DYSPNŒA, OR DIFFICULT BREATHING.

1. BY IMPEDING THE ACCESS OF PURE AIR TO THE LUNGS.

a. *Mechanical.*

Rigidity of parts of the respiratory machine	*e.g.*	Ossification of cartilages; induration of the pleura; rickety distortions.	
Pressure on ditto . .	*e.g.*	Tumors on dropsies of the abdomen.	
Obstructions of the air-tubes	*e.g.*	Effusions in, swellings of, tumors pressing on the air-tubes. Spasm of the glottis; spasm of the bronchi.	
Compression of the lungs	*e.g.*	Effusions or tumors in pleural sac . .	Pleurisy, Hydrothorax, Pneumothorax, Aneurism, &c.

[1] Williams and Clymer, Diseases of the Respiratory Organs, p. 91.

Alterations in the tissue of the lungs	*e.g.*	Engorgement of the vessels. Effusions . . . Œdema, Hepatization, Tubercle, &c. Altered structure . Emphysema, Dilated bronchi, Vomicæ, &c.
b. *Chemical.*		
Deficiency of oxygen in the air	*e.g.*	Mephitic gasses; rarefied air.
c. *Vital.*		
Pain of parts moved in respiration . . .	*e.g.*	Pleurodyne; pleuritis; peritonitis, &c.
Paralysis of muscles of ditto	*e.g.*	Injuries of the spinal marrow in the neck, &c. Paralysis of the bronchi (?).
Weakness of ditto . .	*e.g.*	Excessive prostration from ataxic fevers, &c.
Spasm of ditto . . .	*e.g.*	Tetanus; spasmodic asthma, &c.
2. By the state of the blood.		
a. *Mechanical.*		
Obstruction to the passage of the blood . . .	*e.g.*	Diseases of the heart and great vessels; tumors pressing on them.
b. *Chemical.*		
An excessively venous state	*e.g.*	Violent exertion; idiopathic dyspnœa (?).
Deficiency of red particles	*e.g.*	Anæmia; chlorosis.
3. By the nervous relations of respiration.		
Excessive sensibility of the par vagum . . .	*e.g.*	Hysteric dyspnœa; cerebral fevers; neuralgia (?).
Defective, ditto . . .	*e.g.*	Coma; narcotism, &c. (breathing slow.)

Dyspnœa may come on gradually or insidiously, or it may be violently sudden. The sensation is peculiar and distressing. When continuous, though but slight, it is singularly fatiguing and exhausting; but when severe, even when paroxysmal, it causes intense suffering, attended with a feeling of impending death. There are several degrees of dyspnœa. When the respiratory efforts of the patient do not oblige him to remain seated, it is simply *laborious* breathing. *Orthopnœa* is the highest degree of difficult respiration, in which immediate suffocation seems threatened, and the erect posture is imperatively and instinctively assumed.

Cough is generally symptomatic of disease of the air-passages, but it is believed by many that it may also depend on an affection of other organs, as the stomach, liver, &c., and thus be sympathetic.

The tone or special character of cough varies, and may be *hollow*, or *barking*, heard in the last stages of consumption, chronic bronchitis, and sometimes in nervous affections; *sharp*, or *ringing*, as in croup; *hoarse*, in incipient catarrh, chronic laryngitis, and anginose affections; *wheezing*, as in asthma; or *belching*, in certain diseased conditions of the larynx. It is sometimes *paroxysmal*, as in hooping-cough and hysteria. Cough may be *dry*, attended with no excretion, or *humid* or *moist*, with more or less secretion into the air-tubes.

The auscultation of the cough in health gives a quick, short, commonly dull and indistinct, somewhat diffused sound, without hollow or tubular character, but attended with a distinct sensation of succussion of the interior of the thorax (Walshe). The modifications caused by disease are: 1. *Bronchial*, which is harsh, rapidly evolved, very con-

centrated, with marked succussion, and slight impulsion, and is met with in phthisis, pneumonia, pleurisy, and dilatation of the bronchi. 2. *Cavernous*, characterized by its metallic character and perfect hollowness; strong impulsion, and transmission of sound towards the ear of the listener; and accompanies tubercular excavation and dilated bronchi; and 3. *Amphoric*, of a metallic or ringing character, symptomatic of broncho-pleural fistula, and large tubercular excavation in the lung.

Spitting is the act by which the saliva, and other matters in the mouth are rejected. By *expuition*, or *hawking*, the mucus, &c., accumulated in the pharynx and posterior nares is got rid of, and is attended first by a peculiar inspiratory, snuffing effort, and subsequently with a guttural cough. *Expectoration*, an effect of cough, signifies the expulsion of anything from the air-passages. The *sputa* are the matters which come from the bronchi, trachea, larynx, pharynx, and posterior nares, and are rejected by these different modes. Their character furnishes very instructive signs, and may be studied with reference to *quantity*, *consistence*, *form*, *composition*, *color*, and *odor* in pulmonary disease. They are *scanty* in the first stage of acute affections of the lungs, and may be entirely wanting; they are more *copious* in the decline of acute or subacute disease of the air-passages and lungs; and are abundant in many chronic diseases of these organs. In bronchorrhœa, a pint or more of clear, slightly viscid, and frothy mucus may be expectorated. They vary in *consistence* and may be *serous* or watery, in the forming stage of bronchitis, pulmonary congestion, and vesicular emphysema; *mucous*, more or less viscid, and the result of acute inflammation of the mucous lining of the air-tubes, and of the pulmonary parenchyma, and hence met with in bronchitis and pneumonia; and *purulent*, of the consistence of pus, due to the discharge of an abscess into the air-tubes, and seen in phthisis, and the third stage of pneumonia. The form of the *sputa* depends very much on their consistence. When viscid they are elongated, stringy, and stellated; they are sometimes frothy, flattened, and run together in the vessel, forming a homogeneous mass; and again they may be distinct, rounded, almost hemispherical, as the so-called *nummular* sputa, so often seen in the expectoration of tubercular phthisis, the bronchitis of measles, and occasionally in chronic bronchitis. The sputa sometimes are moulded into the shape of the tube or cavity from which they come. The large, rounded, flocculent, muco-purulent sputa of advanced phthisis, are often such as could only accumulate in a cavity (Williams). Tubular sputa are coughed up in plastic bronchitis and pneumonia. Remak asserts, as the result of his observations, that the sputa of pneumonia invariably contain ramifying bronchial coagula, which appear in the majority of cases between the third and seventh day of the disease, being rarely absent on the fourth and fifth. The basis of the sputa is usually the secretion of the mucous membrane of the air-tubes. Its *composition* varies with the altered products of secretion, and from the admixture of extraneous matter, as blood, tubercular matter, &c. There is great variety in the *color* of sputa. In the beginning of acute affections of the lungs, they are whitish, or ashen; in acute bronchitis, when

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secretion occurs, they are yellowish or greenish; in pneumonia, they are reddish or *rusty*, yellowish or brownish, resembling prune-juice, from the admixture of blood. In bronchitis and the first stage of phthisis, the *odor* of the sputa is faint and sweetish. When secretion is copious in catarrh, the smell is sickening. When purulent matter is expectorated, the odor is fetid. In gangrene of the lungs, it is distinctive, and putrid. When an *alliaceous* odor is perceptible it is a sign of broncho-pleural fistula. An urinous smell of the sputa has been sometimes perceived, and two cases in which it existed have been described by Drs. Haen and Stillé, in which, on examination after death, a continuous passage from the bladder to the lung, was found. When a direct communication exists between the liver and the lung, as occasionally happens, the sputa may be *bilious*.

Pain is another vital symptom connected with disease of the organs of respiration. In acute bronchitis, there is usually a dull, heavy, aching pain, around the base of the chest, which is generally pretty constant. Soreness, too, is complained of in the sternal region and between the shoulders. Pleuritic pain is sharp, lancinating and sudden, and felt below the nipple. In phthisis, patients complain of darting pains from the anterior regions of the chest to the interscapular regions, and frequently about the clavicular regions, which are probably due to pleuritic complication. Constant pain between the shoulders is commonly regarded as a symptom of phthisis, but in Andral's opinion it is merely muscular, due to debility, and met with in many chronic diseases, particularly chlorosis.

Physical exploration of the chest includes *palpation* or the application of the hand, *mensuration*, *percussion*, and *auscultation*. By the application of the hand, we not only obtain results confirmatory of those ascertained by inspection, with regard to alterations of form and of motion (p. 350), but also diagnostic indications derived from *thoracic fremitus* or *vibration*, and the presence of *fluctuation* in the pleural cavities. By *mensuration*, we are enabled to detect with greater accuracy than by inspection, the inequalities of size in the two sides of the chest, already spoken of.

So much for the examination of the chest, by sight, touch, and measurement. We now come to its examination by hearing. There are certain sounds elicited from the chest by striking it (*percussion*), and others which are produced by the act of respiration, and the exercise of the voice, and which we become cognizant of, on applying the ear directly to the thorax (*immediate auscultation*), or with the interposition of a cylinder of wood, called the stethoscope (*mediate auscultation*).

In health, the chest, on being smartly struck, is generally resonant, although not to an equal degree in all portions. Those regions which are most thickly covered will sound duller than those more lightly coated. Whilst the axillary, upper-sternal, and infra-clavicular regions are very resonant from their light covering of muscle and fat; the acromial, infra-scapular, lower sternal, and left mammary are imperfectly resonant, or dull. The modifications of sound, elicited by percussion in disease, are few. There may be *increased clearness* of sound caused by diminished density of the subjacent parts, and an increased

proportion of air within the chest, as in pneumothorax and emphysema; or there may be *diminution of clearness* or even positive dulness, owing to an opposite condition, as in pneumonia, pleurisy, phthisis, hydrothorax, &c. But, in certain diseases of the chest, sounds of a special character are elicited by percussion: 1, the *wooden*, resembling that yielded by mediated percussion of a table, and heard in chronic pleurisy with dense membranes; 2, the *tympanitic*, unnaturally clear and hollow, owing to the increased quantity of air beneath, and met with in pneumothorax and pulmonary emphysema; 3, *tubular*, resembling the sound emitted by the trachea when percussed—it occurs, when the larger bronchi are brought near to the surface, as in pleuritic effusion, and where tubercular cavities exist; 4, *amphoric*, which may be imitated by filliping the cheek, when the mouth is closed and fully inflated, and is observed in large tuberculous cavities; 5, the *cracked-metal—bruit-de-pot fêlé*—resembling the amphoric, but peculiar and distinctive, similar to the sound produced by striking a broken pitcher, and happening in large tuberculous excavations near the surface. Percussion gives another valuable indication, too generally overlooked—*the sensation of resistance* in the part percussed—depending on increased density in the subjacent lung. Where the sense of touch is more delicate than that of hearing, this source of diagnosis is of great value. In acute phthisis, where, from the similar condition of both lungs, there is no means of comparison, it is often a precious sign.

By pulmonary *auscultation* is meant, the listening to the sounds produced in the lungs by the respiratory function. These consist in modifications of the natural respiratory murmurs, and adventitious sounds, which supersede them, called *ronchi*. Natural respiration may be variously altered. It may be *exaggerated*—increased intensity of the inspiratory and expiratory murmurs—and occur in the portions of lung adjoining those rendered unfit for the purposes of respiration, by *obstruction*, *condensation*, or *rarefaction*. It is sometimes called *supplementary* respiration. *Weak* respiration is diminished intensity and duration of the respiratory murmurs, caused by the existence of an obstruction to the entrance of air in the part where it exists. The respiration may be totally *suppressed*, no air entering the region where it is met with, as where a plug of hardened mucus fills up a large bronchus. It is sometimes *incomplete*, the inspiratory murmur being deficient at its beginning or close; this accompanies spasmodic asthma. *Jerking* respiration is where the inspiratory murmur is interrupted, and not evenly continuous, and is met with in incipient pleurisy, spasmodic asthma, and certain cases of tuberculous infiltration. *Bronchial* respiration resembles the natural respiration heard where the large bronchial tubes exist—the top of the sternum and root of the lung; both murmurs are blowing, harsh, and dry, with increased intensity and prolonged expiration; it accompanies condensation of the pulmonary tissue, and occurs in pneumonia, tubercles, &c. The respiration is said to be *cavernous* when it resembles the sound produced by blowing into a hollow vessel; and *amphoric*, when it gives the sensation of air passing into a large empty cavity, and may be imitated by blowing into a

jug two-thirds full. They are met with in large tuberculous excavations.

The various *rhonchi* are sounds which mask or suspend the natural murmurs of respiration, originating in the bronchi, and excavations of the pulmonary tissue, and caused by the passage of air along bronchi of altered caliber, or by air bubbling through fluid contained in these tubes, or in cavities in the lung. The rhonchi are either *dry* or *humid*.

$$\text{Rhonchi}\begin{cases}\text{Dry}\begin{cases}\text{Sibilant,}\\ \text{Sonorous,}\\ \text{Dry crackling.}\end{cases}\\[2ex] \text{Humid}\begin{cases}\text{Crepitant,}\\ \text{Subcrepitant,}\\ \text{Mucous,}\\ \text{Cavernous.}\end{cases}\end{cases}$$

The *sibilant* and *sonorous* rhonchi are present in bronchitis, unaccompanied by secretion, and are produced by the modified caliber of the air-tubes. *Dry crackling* rhonchus is composed of a succession of minute, dry, short, sharp, crackling sounds, few in number, rarely exceeding three or four in a respiration, coexisting with inspiration. (*Walshe.*) It is heard in the first stage of phthisis, and is indicative of unsoftened tubercle in moderate quantity.

Crepitant rhonchus resembles the sound produced by rubbing a lock of hair between the fingers, near the ear, or by the crepitation of salt on coals. It is the physical sign of pneumonia in the stage of engorgement, and in that of resolution. In *subcrepitant* rhonchus, the sound is more moist, and gives the idea of a greater amount of liquid. It is caused by the passage of air through minute bronchial tubes containing liquid of variable consistence. It occurs in capillary bronchitis, idiopathic, and tubercular; pneumonia, at the period of resolution; pulmonary apoplexy; and œdema of the lung. *Mucous* rhonchus is produced by bubbles of large size, traversing liquid in bronchi of moderate or large size. *Cavernous*, or *gurgling* rhonchus, is the bubbling of air through liquid, in a pulmonary cavern, and has a peculiar, hollow, metallic sound, and attends tuberculous excavations.

When the surfaces of the pleura become changed by disease, sounds are produced, giving the sensation of *friction*, which may be detected by auscultation.

On the application of the ear to the healthy chest, when an individual is speaking, a diffused buzzing is heard; except over the upper part of the sternum, over the large bronchial tubes, and on the middle line posteriorly, over the division of the trachea, and on either side of that division, between the spines of the scapula, and in the axilla, where the voice, imperfectly articulate, is transmitted with some degree of force and distinctness, constituting *natural bronchophony*. In disease, several modifications of *vocal resonance* occur. It may be *diminished* in intensity, or be entirely *suppressed*, from the feeble conducting power of the substance of the lung, or intermediate substance, as in vesicular emphysema, and pneumothorax; or, it may be *exaggerated*, constituting *bronchophony*—the unnatural density of the pulmonary

tissue surrounding the bronchi rendering it a better conductor of sound. This happens in tuberculous accumulation, and in pneumonia in the stages of hepatization. There is a peculiar modification of vocal resonance, to which Laennec gave the name of *ægophony*, from its tremulous, nasal, and metallic tone, resembling the bleating of a goat. It is audible over a limited surface, and its position may alter with the posture of the patient. The physical cause of this sign is generally a thin stratum of fluid usually contained in the pleura, and it, of course, is a sign of pleurisy, after effusion has taken place. *Pectoriloquy* signifies a state of vocal resonance in which the voice appears to resound in a hollow space, and is transmitted as articulate words to the ear of the observer. In its most perfect state, the patient appears to speak directly into the ear. (*Walshe.*) The presence of an excavation, or dilated bronchus, whose condition permits free vibration, is necessary for its production, and it is present, therefore, in tubercular caverns and dilated bronchi. When the vocal resonance has a strong metallic tone, it is called amphoric, from its similarity to the phenomenon produced by speaking into an empty pitcher. It is heard in the same affections as amphoric respiration.

If the surface of the chest be auscultated during the cough of a healthy person, a short, dull, and indistinct, and diffused sound, quickly produced, is heard, attended with a sensation of succussion of the interior of the thorax. The morbid modifications of pulmonary cough are three: bronchial, cavernous, and amphoric. *Bronchial* cough is harsher and more concentrated than the cough in health. It is met with wherever there is unnatural density of the lung; when it is compressed by fluid; or the bronchi are enlarged;—as in phthisis, pneumonia, pleurisy, and dilatation of the bronchi. *Cavernous* cough has a hollow and metallic character, and gives the sensation of being produced in a small excavation; there is strong impulsion in its transmission to the ear. It is associated commonly with cavernous rhonchus. *Amphoric* cough is loudly resonant and metallic in its character. It occurs under the same circumstances as amphoric respiration.

There is one phenomenon, detected by auscultation of the chest, which is common to the sounds of the respiration, of the voice, and of the cough—*metallic tinkling*. It is a quick, sharp, ringing sound, closely resembling that produced by gently striking a hollow metallic, or glass vessel, with a pin. (*Walshe.*) It is heard in pneumo-hydrothorax, with bronchial fistula, and it is said, sometimes, in certain excavations of the lungs.

X. The signs derived from the *circulatory* system includes those of the heart and arteries. By auscultation of the heart, we study its *impulse*, its *rhythm*, and its *sounds*. By applying the fingers or ear over the space between the fifth and sixth ribs, a little to the inner side of a line running vertically over the nipple, a gentle and regular pulsation, synchronous with the pulse at the wrist, is perceived, and a slight shock felt. This is the *impulse* of the heart. It varies slightly with the position of the patient. The character of the *impulse* of the heart differs considerably in individuals, irrespective of disease. "It

is full and powerful in the strong and robust; while in the weak and delicate, it sometimes amounts to scarcely more than an undulation, the precise situation of which it is sometimes difficult to determine. In the vigorous, but calm individual, it is strong, heaving, and diffused; in the weak, nervous, and excitable it is smart, smacking, and very defined, or, as it were, concentrated; when, indeed, the organ itself and the arteries leading from it are healthy, the impulse of the heart resembles in character and power, as well as in frequency, the pulse at the wrist."[1] A smart, or smacking impulse should not be confounded with a forcible, or heaving one. The first is indicative of an irritable, and, usually, a weak heart, whereas a deep, heaving impulse accompanies a full or hypertrophied heart. In disease, as in health, a close correspondence will be observed between the impulse of the heart and the pulse at the wrist, unless some mechanical impediment exists to the course of the blood. In fevers and inflammations, when the pulse is strong, so is the heart's impulse; when the pulse is feeble and depressed, the impulse is so likewise; and when the pulse is small and vibratile, after hemorrhage, in anæmia, &c., the impulse manifests the same quality. In simple hypertrophy, the impulse is full, strong, and heaving, lifting the head of the listener from the chest, and somewhat diffused. In hypertrophy with dilatation, the impulse is more powerful, and may be often felt over the whole præcordial region. In simple ventricular dilatation, the impulse is feeble, scarcely amounting to more than a gentle tremor, but greatly diffused. In anæmic and nervous persons, or in atrophy of the muscular walls of the heart, with fatty degeneration (§ 544), the impulse is often exceedingly sharp, smart, and concentrated. When obstruction to the circulation exists anterior to the tricuspid valve, the impulse is visible at the scrobiculus cordis. When the mitral valve is diseased, and there is partial regurgitation through the left auriculo-ventricular opening, along with the impulse at the scrobiculus cordis, there is frequently perceptible impulse between the cartilages of the third and fourth, or even second and third ribs of the left side. In pericarditis, the impulse varies in degree and situation with the amount of effusion.

When the ear is placed on the præcordial region, a regular succession of sounds is heard, with regular intervals—a long sound, a short sound, and an interval, making a complete circuit of the heart's function. The regular performance of this constitutes the *rhythm* of the organ.[2] When the proper relation of the sounds to each other and to the interval is preserved, the rhythm is *natural;* when such relation is disturbed, and there is an alteration in the natural succession of sounds and intervals, the rhythm is *unnatural*, and the action of the heart is said to be *irregular*. When this irregularity recurs at stated intervals, it constitutes *intermittence*. Anything which unnaturally excites the action of the heart, as a moral impression or physical impediment, may disturb its rhythm. The most frequent cause of altered rhythm in

[1] A Clinical Introduction to the Practice of Auscultation, &c. By H. N. Hughes, M. D., p. 202.

[2] Carpenter's Principles of Human Physiology, 3d edit. p. 549.

disease, is valvular change. In great dilatation of the heart, and atrophy of the walls of the ventricles, the rhythm is altered; as well as in large effusions into the pericardium.

The natural sounds of the heart, it has been already stated, are two; the first, dull and prolonged; the second, short and sharp, with hardly an appreciable interval between them, and may be fairly represented by the syllables *lub-tub—lub-tub*. Now the tone of these sounds may be unnaturally increased, or become louder as well as clearer, as in dilatation of the cavities, with thinning of the walls, without valvular disease; when the sounds are only clearer, or shrill, there is only muscular atrophy of the parietes. A decrease in the cardiac sounds may be due to several causes; as whatever interferes with the free action of the heart or its valves; and preternatural thickening of the walls, or hypertrophy. The natural sounds of the heart may in disease become masked, or be replaced by unnatural sounds, called *murmurs*. These murmurs depend on conditions existing either in the cardiac cavities, or within the heart; or in the pericardium, or outside of the organ.

Endocardial Murmurs	Blowing Murmur	Bellows murmur
		Rasping "
		Filing "
		Sawing "
		Musical "
Exocardial Murmur	Rubbing murmur and its varieties.	

The endocardial murmurs are indicative 1st, of valvular lesions; 2d, of diseases of the constituents of the blood, as anæmia, &c.; and, 3d, of nervous disease of the heart. The exocardial murmur, which is always a friction sound, results from the attrition of two roughened surfaces, and is symptomatic of pericarditis. For farther information regarding the semeiotic value of these murmurs, the reader may consult the numerous special works on the subject.

The influence of disease upon the *pulse* is very great; and the different varieties of pulse are amongst the most valuable signs (§ 607). A great variety of pulses have been described, but all the important modifications of the pulse in disease may be included under two heads: 1st, the force and intensity of the pulsations; and 2d, the rhythm or relation of the pulsations to each other. A *strong* pulse is that which resists compression by the finger, and accompanies inflammatory affections, particularly of the parenchyma of the solid viscera, as the lungs and liver; and the active hemorrhages. The condition of the vascular system at the time of attack, influences the production of this form of pulse. In plethoric individuals, and those of strong constitution, anything, which deranges the circulation, will cause a strong pulse; and, therefore, it should not be always taken as an indication of the degree of inflammation. A *weak* pulse, where the artery is easily compressible, is met with under different circumstances; as in all diseases attended with prostration, and in nervous and chronic affections, especially when caused by perverted nutrition. It may be produced by fear. The diseases of children, old persons, and women, often exhibit

this pulse. A *full* pulse is where the volume of the artery seems increased. It is the natural pulse of plethoric, thin, and tall persons, and occurs in all those diseases in which the pulse is strong, as well as in cerebral congestion and apoplexy, and in cardiac disease, particularly hypertrophy, with valvular complication. A *small* pulse gives the sensation of diminished diameter on being felt. It is caused often by narrowing of the aortic orifice, and, when present, should induce examination of the heart. It is the pulse of the serous phlegmasiæ, as peritonitis, pericarditis, inflammations of the stomach, intestines, bladder, &c.; it is met with in hysteria, hypochondriasis, and other nervous affections, as well as in chlorosis; in the cold stage of fevers; and in diseases attended with violent paroxysms of pain. It is a symptom of adynamic and ataxic diseases, and of purulent resorption. Sometimes the artery feels like a thread beneath the finger—this is the *filiform* pulse. When a vibratory sensation is communicated to the finger, the pulse is said to be *hard*, *sharp*, or *contracted;* this is called, also, a *corded* pulse. It is encountered in the membranous phlegmasiæ, sanguine congestions, active hemorrhages, neurosis, lead colic, &c. A *soft*, compressible, or liquid pulse, depends on a diminution of the tonicity of the arteries (§§ 123, 607), and yields with great readiness to pressure. In some adynamic affections, the pulse, though apparently distended, on slight compression, gives way—this variety of the soft pulse has been termed *gaseous*, from the sensation experienced by the finger of the examiner. The pulse is *quick*, when the arterial stroke or diastole is very rapid, without any diminution in the intervals of pulsation; though generally associated with a frequent pulse, it is distinct from it.

In the healthy adult the number of pulsations in a minute may be stated at 75; but it is liable to great variation from a number of causes, as position, &c.[1] A *frequent* pulse is where the natural number of pulsations is considerably exceeded. It constantly accompanies all febrile and inflammatory diseases, hemorrhages, &c. A *slow* or *infrequent* pulse, in which the number of pulsations falls below the healthy standard, occurs in apoplexy, acute tubercular meningitis, in some adynamic affections, occasionally in disease of the heart, &c. An *equal* pulse is that, in which the pulsations in a given time are alike in fulness, resistance, quickness, and velocity. The pulse is *unequal*, when the pulsations differ from each other in this respect. Inequality in rhythm is called the *dichrotous* pulse, which gives the sensation of a double beat, and has been compared to the rebounding of the hammer on the anvil. It is observed in convalescence from fever and other diseases (§ 123). When a pulsation or beat fails, at regular and uncertain intervals, the pulse is called *intermittent.*

When the stethoscope is placed over a large artery, a peculiar, dull sound is heard synchronous with the ventricular systole; this may be masked or replaced by an unnatural murmur. Of all the unnatural murmurs heard in ascultation of the arteries, the blowing sound, and its various modifications, are the most common. It most frequently

[1] Carpenter's Principles of Human Physiology, 3d edition, p. 555.

occurs in connection with diminution of the red corpuscles of the blood, as in anæmia, chlorosis, &c.; but may be caused by ossification, dilatation of the walls of the arteries; or from compression of the vessel by a tumor.

XI. The signs derived from the *digestive organs* next claim our attention.

The state of the *tongue* in disease has always been considered of great importance, and has been already alluded to (§ 607). Although the importance of the signs which it furnishes have been exaggerated, they are interesting and valuable. The tongue in disease is to be studied in connection with its modifications in volume, form, movements, color, degree of moisture, nature of its coatings, its temperature, and sensibility. Diminution in the size of the tongue is a frequent symptom in typhus and other low fevers; it is at the same time generally trembling and dry—conditions of equal gravity. A pointed, conical tongue was once supposed sufficient to establish the existence of gastritis. Experience has shown, however, that it indicates neither the nature nor the seat of the disease, or its danger, and that it depends entirely on the manner of contraction of the muscles of the organ. Impeded movement and distortion are valuable, as unfavorable signs in fevers as well as in cerebral disease. In paralysis, the deviation is usually more apparent than real; its seat being the buccal commissure and not the tongue. When the tongue presents on its upper surface a coating, it is generally evidence of some morbid condition. Fasting will, in some persons, produce a white fur, and others who sleep with their mouth open are liable on waking, to have the tongue dry and dirty. Does the tongue faithfully represent the state of the stomach? The results of careful and repeated observations on the part of Dr. Louis indicate, on the contrary, a great degree of independence of the conditions of the tongue and stomach. His observations, confirmed by others, show that the aspect of the tongue bears no relation whatever to that of the stomach; the same state which coincides at one time with decided disease of the stomach, occurs at others where this organ is healthy. Albuminous exudation on the surface of the tongue is unconnected with any particular state of the stomach, but is a phenomenon of singularly bad augury, as it rarely appears until a few days before death. It occurred in one-eighth of the cases of phthisis observed by Dr. Louis.

The *appetite* may be increased in disease to a degree constituting voracity, or *bulimia*, which is sometimes seen in pregnancy, hysteria, and insanity. Generally, however, it is diminished, and there is indifference (*anorexia*), or actual aversion to food. This is seen in most acute diseases. The appetite may be perverted, and articles which are noxious or disgusting may be eagerly sought after.

Thirst is increased in acute affections, particularly of the stomach and bowels, after hemorrhage, and in diabetes. It is abolished in some cerebral diseases, and where there is coma.

Vomiting occurs under various circumstances. It is a frequent initial symptom of acute inflammatory and febrile affections. It is an

early symptom of pregnancy; of lead, hepatic, and nephritic colic; of cerebral disease; and of hernia.

Pain in the abdomen may proceed from various causes; it may be due to inflammation of some of the contained viscera, and in that case it is aggravated by pressure; or it may depend on over distension of some portion of the digestive tube; on neuralgia; hepatic, renal, intestinal, and lead colic, and is then generally relieved by pressure.

Dysentery is often attended with a sharp burning pain, with a strong desire to go to stool; this is called *tenesmus.* Acute colicky pains are termed *tormina.*

The *feces* frequently undergo very important modifications. Their consistence when liquid may vary from that of water to that of pap. They are watery in serous diarrhœa, and Asiatic cholera; in chronic inflammation of the colon they are mucous, and resemble white of egg. Sometimes they are harder than in health; this is particularly the case in lead colic, and also, it is said, in cancer of the stomach. In these diseases, they often resemble the excrement of sheep, forming small, black, hard balls. The color of the feces varies. When there is deficiency of bile, they are of a grayish-white or clay-color; when it is in excess, they are yellow or dark brown; a dark-greenish hue is commonly thought to depend upon the presence of bile, and this is particularly observed in children after the administration of calomel, but Dr. Golding Bird has shown it to be due to the presence of blood. Rhubarb stains the feces yellow. In dysentery they are reddish, or streaked with blood. When the blood is dark, and mixed with the feces, it usually comes from the superior portion of the intestinal canal. In melæna, the stools are of a pitchy blackness. When the blood is pure, and the evacuations are unattended with colicky pains, it is hemorrhoidal. The feces are semitransparent and colorless in Asiatic cholera, with whitish clots, and resemble rice water or turbid whey. The preparations of iron give them a black color. The alvine evacuations may contain shreds of false membrane, as in dysentery and diarrhœa, biliary or intestinal calculi, worms, &c. In diabetes and phthisis they often abound in fat. In some diseases they become intolerably fetid. In adynamic diseases they are very offensive, and in chronic dysentery exhale a peculiar cadaverous odor. (For much interesting information on the intestinal excretions, consult Simon's *Animal Chemistry*, &c., translated by Dr. Day.)

XII. The signs derived from the urine are highly valuable, not only as regards the urinary apparatus, but other organs, and the system generally (§ 607). Many of these have already been noticed, and their semeiotic value indicated (§§ 167, 176, 249, 254, 255, 257, 260, 309, 384, 385, 448, &c.). We shall notice them here very briefly.

Disease influences the *quantity* of urine passed. A healthy adult usually secretes during the day a pint and a half to three pints. In some affections of the kidneys there is complete *suppression*, no secretion taking place. The writer recently saw a case in which there was complete suppression during five days, without the supervention of coma. The patient recovered from that attack, but succumbed, without

the occurrence of comatose symptoms, to a second one; and, on examination, both kidneys were found extensively disorganized. In most inflammatory and febrile diseases, there is diminution in the quantity of urine, as well as in dropsy. *Retention* of urine—where it is secreted, but retained in the bladder—occurs as a consequence of paralysis, in typhoid fever, in hysteria, &c. *Increase* in the amount of urine takes place in diabetes, in the cold stage of fevers, and in hysteria. Fear, terror, and other passions of the mind, frequently render this secretion extremely copious. The *tints* of the urine in different maladies are of importance; they vary from nearly colorless, to the usual pale amber color, up to deep brown. In chlorosis and hysteria, the urine presents a slight greenish hue; if bile or blood be present, a variety of colors varying from red to brown, blackish-green, or apple-green, are produced—the latter hue being occasionally indicative of the presence of cystine. Urine sometimes varies in *consistence*, and instead of its usual fluidity, acquires some degree of viscidity; in some cases only to be detected by the readiness with which it froths on agitation, and the length of time the bubbles remain, as in diabetes mellitus; and in others sufficiently so to allow of being drawn into threads, from the presence of mucus, or pus in very concentrated and alkaline urine—the alkali reacting on the albuminous constituents of the pus, and converting it into a mucous magma, as pointed out by Drs. Babington and Golding Bird. In some rare cases, urine fluid when warm, becomes semisolid like jelly, on cooling, from the presence of albumen or fibrine; this generally betokens some organic renal disease, though it is said to happen also in functional disturbance. Dr. Golding Bird states that in a few rare instances he has found urine, which was quite fluid whilst cold, gelatinizing when heated; it was loaded with oxalate of lime. The odor of the urine in adynamic fever, after lesions of the spinal marrow, when long retained in the bladder, &c., is offensively ammoniacal. The following are the general characteristics of the urine in inflammatory affections: It is darker, being of a yellow, brown, or reddish-brown tint; has an acid reaction; and augmented specific gravity. The urea may be absolutely increased, at or below the natural standard; the salts are always absolutely diminished. The composition of the urine becomes changed, if much blood is abstracted during the progress of the inflammation; it becomes clearer, specifically lighter, and the amount of urea decreases absolutely and relatively. At the height of the inflammation, the urine is clear and deeply colored; when it subsides, there is a yellow or reddish sediment of uric acid and urates.

The *chemical composition* of the urine has within a few years attracted a good deal of attention, as well as its microscopical examination; and by these means the several urinary deposits have been very attentively and advantageously studied. Deposits of *uric acid* and its combinations, present every shade of intensity of tint, from the palest fawn-color to the deepest amber or orange-red, and are often called *red* or *yellow sand sediments*. They occur in fever, in acute inflammation, in rheumatism, in phthisis, in all the grades of dyspepsia, in all or most stages of diseases attended with arrest of perspiration; in diseases of the genital apparatus; from blows and strains of the

loins; from excessive indulgence in animal food; or, the quantity of food remaining the same, from too little exercise. The *earthy phosphates* (phosphate of lime, ammonio-phosphate of magnesia, and carbonate of lime), are always white, unless when colored with blood; soluble in dilute hydrochloric acid; and insoluble in ammonia and liquor potassæ. On heating the urine, the deposit agglomerates into little masses. The occurrence of deposits of the earthy phosphates should be regarded as of serious importance, always indicating the existence of important functional, and, too frequently, of organic mischief. One general law appears to govern the pathological development of these deposits—that they always exist simultaneously with a depressed state of nervous energy, often general, rarely more local, in its seat (Bird). Deposits of oxalate of lime are regarded by Dr. Golding Bird as by no means so rare as is generally supposed, and he believes that it owes its origin to sugar, and is caused by derangement of the digestive organs. The urine may contain all or any of the elements of the blood. The serum may be alone effused, or be accompanied with the red globules. Whenever the elements of blood appear in the urine, there is ample proof of the existence of active or passive hemorrhage of the kidneys or urinary tract. *Albuminous* urine occurs in Bright's disease, dropsy after scarlatina, &c. *Pus* is met with in the urine as the result of suppuration of the kidney, or of some portion of the genito-urinary mucous membrane, or of abscesses from adjoining viscera, opening into urinary cavities. The quantity of *mucus* in urine may vary under the influence of different degrees of irritation or inflammation, from a mere cloud to a viscid and tenacious fluid. The general indication of mucous deposits is an irritated or inflamed state of the genito-urinary mucous membrane. The presence of sugar in the urine is not uncommon in dyspepsia, and, when excessive, is an important sign of diabetes mellitus. The urine of pregnant women sometimes contains a whitish, opalescent, greasy pellicle, called *kiesteine.*

The following simple and concise rules for the *clinical examination of the urine*, condensed from Dr. Golding Bird's admirable work on *Urinary Deposits* (2d Am. Ed.), and from other sources, will serve as a guide for the immediate examination of the urine in the sick-room:—

I. *Urine without any visible Deposit, or decanted from the Sediment.*—If the urine be acid, a piece of litmus-paper immersed will be changed to red. Should no change occur, a piece of reddened litmus-paper should be dipped in, and, if the urine be alkaline, its blue color will be restored. When the urine is neutral, the tint of the test-paper is unchanged.

A portion of the urine should be heated in a small test-tube, over a spirit-lamp; and, if a white deposit takes place, it is evidence of the presence of albumen or of the earthy phosphates; if the latter, a drop of nitric acid redissolves the deposit.

If the urine be very high colored, and not rendered opaque by boiling, the coloring matters of bile or purpurine are present. Pour a thin layer on the surface of white porcelain, and add a few drops of nitric acid in the centre; if it be bile, there is an immediate and rapidly ending play of colors from bluish-green to red; if purpurine, there is no

change. When heat alters the color and transparency of high-colored urine, blood is probably present.

Excess of uric acid exists when, on adding nitric acid to deep-red urine, unaffected by heat, a brown deposit occurs.

In a specimen of pale urine immerse the gravimeter, and if the sp. gr. be below 1.012, there is a great excess of water; if above 1.025, there is either a large excess of urea, or sugar is present. If the former, by placing a few drops of the suspected urine in a watch-glass, and adding an equal quantity of nitric acid, and floating the glass on some cold water, crystals of the nitrate of urea will very soon be seen. To test for sugar, boil a small portion of the urine with an equal bulk of liquor potassæ in a test-tube; the existence of sugar is shown by the development of a brown color.

If an excess of coloring matter, rich in carbon, be sought for, add a few drops of hydrochloric acid to hot urine in a test-tube; if there be only an average proportion of pigment, a faint red or lilac color will be produced; if it be in excess, it will be shown by a dark red or even a purple tint.

In alkaline urine, if a drop of nitric acid be added, and a white deposit occurs, albumen is present. If brisk effervescence follows the addition of the acid, the urea has been converted into carbonate of ammonia.

II. *Examination of the Sediment Deposited.*—If the deposit is flocculent, easily diffused on agitation, and scanty and not dissolved by nitric acid, it is chiefly made up of healthy mucus, epithelial cells, and occasionally, in women, of vaginal and uterine secretions.

If the deposit is ropy and apparently viscid, add a drop of nitric acid; if it is wholly or partially dissolved, it is composed of phosphates; if but slightly affected, of mucus. If the sediment falls like a creamy layer to the bottom of the vessel, the supernatant urine being coagulable by heat, it is pus.

Urine sometimes appears opaque, from the presence of a light flocculent matter diffused through it, neither presenting the tenacity of mucus nor the dense opacity of pus. Although scarcely sufficient in quantity to interfere with the perfect fluidity of the urine, if a little be placed in a test-tube, and agitated with an equal bulk of liquor potassæ, the mixture will often become a stiff transparent jelly. This peculiar appearance is demonstrative of the presence of the exudation, or large organic, globules formed under the influence of irritation, providing the urine does not coagulate by heat, for, should it do so, the existence of minute quantities of pus may be suspected. (*Bird.*)

If the deposit is white, it may consist of urate of ammonia, phosphates, or cystine. The first will disappear on heating the urine; the second, on the addition of a drop of diluted nitric acid; whilst ammonia dissolves the third, the urine usually emitting an aromatic, and occasionally a fetid, odor.

If the deposit be colored, it may consist of red particles of blood, uric acid, or urate of ammonia, stained with purpurine. If the first, the urine becomes opaque by heat; if the second, the deposit is in visible crystals; and, if the third, the deposit is amorphous, and dissolves on heating the fluid.

Oxalate, and more rarely oxalurate of lime, are often present diffused through the urine, without forming a visible deposit; a drop of the suspected urine examined microscopically will detect the characteristic crystals.

If the urine be of milky opalescence, with a cream-like layer on its surface during repose, an emulsion of fat with albumen is probably present. Agitate some of the specimen with half its bulk of ether, in a test-tube, and, after resting a few minutes, a yellow etherial solution of fat will float on the surface; a tremulous albuminous coagulum forming beneath it.

The two following rules should be borne in mind, and will much facilitate the examination:—

If the deposit be white, and the urine acid, it, in the great majority of cases, consists of urate of ammonia; but should it not disappear by heat, it is phosphatic.

If a deposit be of any color inclining to yellow, drab, pink, or red, it is almost sure to be urate of ammonia, unless visible crystalline, in which case it consists of uric acid.

The following tables of Dr. Bird briefly point out the readiest mode for the examination of crystalline deposits, both by chemical tests and by microscopic examination. The latter mode is the preferable one, from the information being more reliable and extensive, and from the economy of time:—[1]

a. *Table for discovering the Nature of Urinary Deposits by Chemical Reagents.*

1.	Deposit white	2	
	——— colored	5	
2.	——— dissolves by heat		Urate of ammonia.
	——— insoluble by heat	3	
3.	——— soluble in liquor ammoniæ		Cystine.
	——— insoluble in ———	4	
4.	——— soluble in acetic acid		Earthy phosphates.
	——— insoluble		Oxalate and oxalurate of lime.
5.	——— visibly crystalline		Uric acid.
	——— amorphous	6	
6.	——— pale, readily soluble by heat		Urates.
	——— deeply colored, slowly soluble by heat		do. stained by purpurine.

b. *Table for the Microscopic Examination of Urinary Deposits.*

1.	Deposit amorphous	2	
	——— visibly crystalline	3	
2.	——— vanishes on the addition of liquor potassæ		Urate of ammonia.
	——— permanent after the addition of ———		Phosphate of lime.
3.	Crystals in well-defined octahedra		Oxalate of lime.
	——— not octahedral	4	
4.	——— in six-sided tables soluble in ammonia		Cystine.
	——— not tabular, nor soluble in ammonia	5	
5.	——— soluble in acetic acid	6	
	——— insoluble in acetic acid	8	
6.	——— imprisms or simple pennæ		Neutral triple phosphate.
	——— radiated or foliaceous	7	

[1] [The microscope required for the examination of urinary deposits is simple and unexpensive. A complete, excellent, and economical instrument is manufactured and sold for about fifty francs ($10), by M. Nachet, of Rue de Serpente, Paris.—C.]

7.	Crystals soluble in acetic acid with effervescence .	Carbonate of lime.
	——— ——— without effervescence	Bibasic-triple phosphate.
8.	——— in dumb-bells or radiated . . .	Oxalurate of lime.
	——— spherical or colored 9	
9.	——— in lozenges or compound crystals . .	Uric acid.
	——— in spherical crystals	Urate of soda or ammonia.

(Much valuable information on the subject of the urine in disease may be had by consulting Simon's *Chemistry of Man*, and the excellent manuals of Dr. Golding Bird, Rees, Griffith, Markwick, &c., all of which are republished in this country.)

XIII. The *cutaneous exhalation*, or *perspiration*, presents numerous points of semeiotic value. The average quantity of fluid transpiration is estimated at twenty-nine ounces daily, containing from seven to eight scruples of solid matter. Children perspire more profusely than adults, and men more than women. Profuse perspirations occur in acute rheumatism, and towards the decline of acute inflammations and fevers, and in the latter case are often critical. The night-sweats of phthisis are profuse and debilitating. The perspiration may be diminished or suspended, as during the early stage of acute disease, and in dropsy and diabetes. Perspiration may be *general* or *local;* it may be confined to the forehead, palms of the hands, epigastrium, soles of the feet, &c. Local sweats are sometimes critical. A case of this kind is mentioned, in which the sweat stood in drops on the feet, fresh drops springing up as fast as the feet were wiped; and it was curious that the surface affected occupied the posterior half only of each sole.[1] The odor of the perspiration is naturally slightly acid. In rheumatism and in gout this becomes excessive. The odor is fetid sometimes in adynamic fevers; mouldy in measles and scarlet fever; and ammoniacal occasionally in typhoid fever. In insanity, a peculiar odor has been noticed; and that of military sweat has been compared to the smell of chlorine, or rotten straw. A case in which sugar was detected in the sweat of a diabetic patient has been recorded by Nasse.

XIV. The symptoms furnished by *animal heat* are various. The *temperature* of the human body may be increased; this may be general or local. In idiopathic and symptomatic fever there is general heat of the surface (§ 437).

In external local inflammation there is always at least the sensation of heat (§ 431); and the skin of the forehead is often hot in cephalalgia; the scalp in cerebral disease; the integument of the chest in thoracic inflammations; the hands and feet in phthisis, &c. Heat may be permanent or transient. There are different varieties of heat. The acrid heat of typhus fever, giving to the hand a peculiar burning sensation, increased by prolonged contact, is called *color mordax.* *Diminution* of temperature, or *cold*, presents the same varieties in relation to its intensity, seat, type, and peculiar character. *Coldness* is a simple sensation of cold; *horripilation* is accompanied with contraction of the skin and the bristling of the hairs over the surface; a

[1] British and Foreign Medical Review, vol. xx. p. 312.

rigor is attended with involuntary tremor. A *chill* of more or less intensity occurs as an initial symptom of febrile affections, and of the phlegmasiæ, particularly pneumonia. In cyanosis, the temperature of the body is generally low; and this symptom is very common when the circulation, from whatever cause, is languid. Nervous and anæmic persons suffer from coldness of the hands and feet.—C.]

611. The *diagnosis* of diseases is the distinction of diseases from one another. It may relate to diseases in their essential nature or pathology, or to those groups of symptoms that are classed as separate diseases by nosological arrangements (§ 597). In other words, the object of diagnosis is to determine, either the intimate nature and seat of a disease, or its name and place in a classification of phenomena, grouped under the name of special diseases. According to the nosological arrangement, which has been recommended as the best at present (§ 600), the division into special diseases is as much as is practicable, founded on pathology, or the essential nature of disease; and diagnosis should also have a corresponding reference to this subject. But as it has been admitted that pathology is not sufficiently advanced to be the sole basis of nosology, so we must avail ourselves of other sources of information in regard to diagnosis. Accordingly, much of the materials of diagnosis are the results of simple observation or clinical experience; and where these cannot be analyzed by any more rational mode, they may be measured or valued by *the numerical method*, or counting and calculating the results in a large number of cases. Thus, diagnosis is chiefly derived from semeiology, and the results of clinical experience, arranged by pathology and statistics. In some instances, the causes and the treatment of disease give aid in the diagnosis. Thus the malarious character of a patient's residence, and the efficacy of quinia in curing him, will contribute important evidence as to the nature of his disease.

612. Diagnosis may be *general* or *special*. *General* diagnosis comprehends the distinction between the principles or elements of disease (§ 104); as, for example, between congestion and inflammation; between nervous irritation and structural disease, &c. *Special* diagnosis relates to the distinction of diseases according to their chief seat, where they have one (§ 599), or according to some other specific difference, where they have no particular head-quarters. Thus the special diagnosis of inflammations is between inflammation of the parenchyma of an organ and that of its investing membrane; or between an intermittent and a continued fever. Special diagnosis also follows and distinguishes diseases in their farther differences of seat or character; as the part or extent of a parenchyma or membrane inflamed, the type of a fever, &c. Thus special diagnosis is a branch of special pathology, and should be aided by an accurate and practical nosological arrangement. The mode of distinguishing between two diseases which resemble each other has been absurdly called *differential diagnosis*. It consists in pointing out the signs which are essential to the one and not to the other. The signs called pathognomonic, where they exist, are the chief guides in differential diagnosis.

613. The modes of investigating and distinguishing diseases will vary much in different cases, according to the class of symptoms that first present themselves. This may be illustrated by the following problems :—

General pathology having pointed out the general nature of a disease, it is required to determine its precise seat. *Example.* In a case in which fever, hard pulse, buffed blood, and local pain indicate inflammation, the seat of the inflammation is determined by the chief seat of pain or uneasiness (in the chest or side), by the function most disturbed (difficult breathing and cough), to be in the organs of respiration; by the secretion proceeding from the part (rusty, viscid expectoration), and from the physical signs (impaired breath-sound and stroke-sound in part of the chest, with crepitant rhonchus), to be in the parenchyma of the lungs; that is, pneumonia. General pathology here commences the diagnosis, which is completed by reference to symptoms explained by physiology and special pathology.

Previous history, prominent symptoms, or physical signs, having pointed out the seat of a disease, it is required to determine its nature. *Example.* A person suffers from severe pain at the epigastrium; the previous occurrence of symptoms of indigestion, and the situation of the pain, plainly show the disorder to be seated in the stomach; the nature of the disease (whether nervous or inflammatory, &c.) is to be determined by general pathology; guided by this, and finding an absence of symptoms of inflammation, no increased heat of surface, no acceleration of the pulse farther than what the pain would cause, and no increase of the pain on the imbibition of warm or stimulating liquids; and finding symptoms of predominate nervous properties, and the sudden attack, intense character, and transient duration of the pain which distinguish nervous and spasmodic affections, we decide that the disease is gastralgia or gastrodynia, and not gastritis. The diagnosis which is begun by local symptoms is completed by reference to the principles of pathology.

Lastly, which is a common case, symptoms being too few or too inconclusive to lead the diagnosis, both the seat and the nature of the disease are to be determined. A person complains of general uneasiness, weakness, and chilliness, with various functional symptoms, but none of a prominent character. Clinical experience has taught the practitioner that such are the symptoms of incipient fever; and he proceeds to investigate farther the nature and cause of the fever. If he finds, on close examination of the functions and physical condition of the different organs, that one is the seat of marked inflammation, and that the fever is not typhoid, he judges that the fever is symptomatic of the inflammation; but if signs of marked local inflammation be absent, yet the fever continues with increasing symptoms of depression, weak frequent pulse, brown dry tongue, sordes on the teeth, low delirium, &c., he recognizes typhoid fever, resulting from the influence of a morbid poison on the system (§ 105).

614. Thus every department of medical knowledge is brought to bear on diagnosis; and in no branch is the information as well as the judg-

ment of the practitioner more brought to a test. Natural shrewdness and tact, with some general knowledge of the nature and treatment of disease, may sometimes enable a comparatively ignorant person to practice medicine with an appearance of success; but such a person can make no hand of diagnosis; and he wisely either evades the whole subject or expresses his opinions in vague terms, and scrupulously avoids their being brought to the test of the scalpel. The well-informed practitioner, on the other hand, feels that this is the subject which requires the full application of his mental powers and knowledge, as well as the keen exercise of his powers of observation; and in proportion as his senses are practised in observing, his information well arranged in relation to what he observes, and his judgment matured in discriminating and deciding the results, so will he be successful in diagnosis, and in applying it to prognosis and practice.

615. In investigating the symptoms of a case with a view to diagnosis, prognosis, and treatment, the observation is first drawn to those which at once declare themselves in the *aspect* of the patient, the expression of the countenance, the complexion, the posture, the manner of the movements, speech, &c.; and these give important information to the observing practitioner at first sight, and whilst he is interrogating the patient. After the first few statements of complaints, which are generally volunteered by the patient, the questions should be directed to the *history* of the ailment, including the *previous state of health and habits*, with regard to food, clothing, occupation, residence, &c., any former illness, *the mode of the present attack*, and its *supposed cause*, the *former symptoms*, and treatment, if any has been employed. The answers to these questions will direct the inquiries in the most searching manner with regard to the *present state* and *symptoms*. The mode of investigating these will partly depend on the clue given by the answers to previous questions; but the practitioner must not permit himself to be so far led by the patient's statements as to omit to examine the state of all the important organs and their functions. The *nervous system and its functions* (sensorial, sentient, excito-motory, and sympathetic); *the organs of circulation and their functions* (pulse of heart and arteries, capillary circulation of surface and visible parts, temperature, state of veins, &c.); *the organs of respiration and their functions* (breathing, cough, expectoration, voice, arterialization of the blood); *the organs of digestion and their functions* (tongue, appetite, digestion, &c.); *the organs of secretion and excretion and their functions* (liver and intestines, kidneys, bladder, and the skin); *the functions of nutrition and assimilation* (to be judged of by the condition of the flesh and comparative weight of the subject); *the organs of locomotion and their functions; the organs of generation and their functions;* are severally to be made the subjects of inquiry and physical examination to such an extent as may be requisite to inform the practitioner of their true condition and connection with the past or present disease.

The object of a complete investigation of the state of the patient is not merely to determine the particular disease under which the patient labors, but to discover what is healthy as well as what is morbid in his

condition. The prognosis or estimation of the amount and event of the disease, and the application of treatment, requires this full investigation. We have to consider, not merely *disease in the body*, but *the body in disease;* and it is by losing sight of this great practical axiom, that minute or microscopic inquirers, who may be singularly successful in special diagnosis, signally fail in prognosis and in practice.

CHAPTER VI.

PROGNOSIS—FOREKNOWLEDGE OF THE RESULTS OF DISEASE.

616. Prognosis is that knowledge by which we are enabled to foresee the course, duration, and event of a disease. Like the treatment of disease, it may be either *empirical* or *rational.*

Empirical prognosis is that which is founded on experience or observation only, without regard to the nature of the disease or the reasons which determine the results. It consists in the observation of the *good* and *bad* symptoms—that is, those symptoms which have, in a great majority of cases, been followed respectively by a good or a bad result. This mode of prognosticating the events of disease was the only one attainable in the early ages of medicine. The "prognostics" of Hippocrates chiefly consisted in the enumeration of good and bad signs; and the frequent truth of the distinctions which he has made on these points, show the extent and accuracy of his observation, or of the sources from which his information was drawn. In a limited sense, the same faculty of empirical prognosis is often acquired by nurses or other non medical attendants of the sick. These can often tell when a patient is getting better or worse, by the appearance of the countenance, the state of the voice, the mind, the strength, the breathing, the excretions, &c., whilst they may be in total ignorance of the nature of the disease and why the signs are good or bad. This kind of prognostic knowledge, although it may be useful in enabling a person to pronounce a patient better or worse, falls far short of that which ought to be expected of the scientific practitioner, who should not only have a greater number of prognostic symptoms within his reach, but should be able to foresee them, so as to anticipate, and, if possible, to influence them in a favorable manner.

617. *Rational prognosis* is the estimation of the importance and tendencies of a disease from a knowledge of its causes, its true nature and symptoms, and of the power of treatment in regard to it. Like rational diagnosis (§ 614), it derives its evidence from all available sources, and makes the best use of this evidence by analyzing it, and thus determining its value. Thus, in the early stage of inflammation of the lung, the discovery of the nature and seat of the affection at once shows the presence of a serious disease, whatever may be the state of the present symptoms. The practitioner, in forming a rational prognosis, takes into account the extent of the inflammation, knowing, from experience as well as from reason, that this is a source of danger; he considers the duration of the attack, and from the signs and symp-

toms judges whether it is increasing or not. These considerations may give him some insight into the severity of the disease, but his prognosis is to be determined by farther conditions. He knows, by experience and reason, that inflammation of the lungs, although always a dangerous disease, becomes much less so when it is at a stage and in a subject in which antiphlogistic remedies can be well borne; thus, at an early stage, in a young and vigorous subject, even the most extensive inflammations may be cured by bloodletting and other means judiciously employed; but if the disease has advanced far, and the function of respiration has been for some days impaired by it; if the subject be feeble, from infancy, or from extreme age, or from previous disease, from intemperate habits, from a complicating disorder, or from any other cause, the prognosis becomes more unfavorable, inasmuch as there is little power in the system to bear the appropriate remedies, or to withstand the evil effects of the disease.

To take an example of another disease. In continued fever, certain symptoms have been found by experience to be of an unfavorable character. The pathological practitioner profits by this experience, but he analyzes the results and goes farther. He knows that the appearance of petechiæ, congested face, and stupor, at the commencement of fever, are bad symptoms, but that they are so, mainly in proportion as they arise from the changed state of the blood induced by the depressing cause of the fever; and when, as it sometimes happens, these symptoms appear without any corresponding depression of the heart's power, as manifest by extreme frequency and weakness of the pulse, they are by no means of such unfavorable import, but may arise from the plethora of the subject. Again; symptoms referable to the excito-motory system (§ 153) —such as subsultus, hiccough, and convulsive affections—are generally unfavorable in continued fever; but they are so only when arising from the severe operation of the cause of the fever on the nervous centres; they are much less so when occurring in a nervous subject, in whom slight causes may induce them. The same remark may be made of a state of stupor, which would be of most serious import if dependent on fever alone; but it may be induced by slight fever, or other cause, in an hysterical subject. The pathologist is prepared for these differences, and can qualify his prognosis accordingly. He can trace the danger of bad symptoms, beyond the symptoms themselves, to those interferences with vital functions which render these symptoms dangerous, and of which these symptoms are not always the true exponents.

618. As our limits do not admit of details, it must suffice to enumerate the chief circumstances from which a rational prognosis may be formed with illustrative examples. These may be arranged under the two general heads: 1. Those relating to the patient or subject; and 2. Those referring to the disease.

619. *The age of the subject.*—Acute diseases are ill borne at either extreme of age, when the powers of reaction are less energetic to sustain the struggle. Hence infants and aged persons are often carried off by acute attacks. Acute diseases prevail more in youth and middle age than in advanced life, in which affections tend to assume a chronic form;

also from want of that power of reaction and resistance by which, in more vigorous age, morbid actions are thrown off. [In early infancy there is always hope, even with the most dangerous symptoms. "*L'enfance est l'age des resurrections,*" says Chomel. It is at this period of life, that the well-known adage *ubi vita, ibi spes*, is so applicable. In old age, on the contrary, acute diseases which assume a severe form almost always terminate fatally. In middle age, the chances are more favorable, and are greatest in youth and adolescence. The exceptions to this rule are the eruptive fevers, which are less dangerous in infancy, and certain organic affections, which are said to advance less rapidly in old age.—C.]

The sex of the patient.—Nervous diseases are most common and obstinate in the female sex; but they are more serious in the male sex. The occurrence of the catamenia is often favorable as their suppression is unfavorable in the course of the disease. Pregnancy and lactation, during their continuance, suspend or retard the progress of tuberculous disease, and other disorders of the nutrient function, and the cessation of these conditions may excite the disorders into fresh activity. Eruptive fevers, especially smallpox and scarlatina, are peculiarly fatal to women during and shortly after pregnancy.

The temperament of the patient.—In the sanguine temperament, disorders are apt to be acute, or tending to a speedy termination, favorable or unfavorable; in the phlegmatic temperament, more chronic, and not uncommonly latent or obscure in their symptoms; whilst in the nervous temperament, the symptoms are very prominent, often exciting much suffering and alarm where little or no danger may exist; and they are likewise remarkable for their mutability.

Previous diseases of the patient.—The same disease having occurred before prevents or renders milder a subsequent attack, in the case of eruptive fevers, hooping-cough, &c.; but increases the tendency and the danger in case of apoplexy and most structural diseases. Albuminuria with dropsy is more curable, when ensuing after scarlatina, than when after other causes; but rheumatism after scarlatina and gonorrhœa is often unusually severe and intractable. After continued fevers, and other debilitating diseases, inflammations often assume a subacute or chronic form, which may escape attention, and produce serious organic disease.

Present diseases of the patient.—These generally increase the severity or intractability of the new disorder, especially if they be structural. Thus infectious disorders and fevers are peculiarly fatal in persons with diseased heart, lungs, kidneys, or brain. Yet moderate hypertrophy of the heart is rather a favorable circumstance in phthisis. Cutaneous and some other external diseases, sometimes suspend attacks of gout, gravel, diarrhœa, &c. Extensive emphysema of the lung supersedes tubercles and most other lesions of the parenchyma, whilst it renders the bronchial surface and liver the seat of almost constant congestion or inflammation. Cancer supersedes tuberculous disease, and reduces the proneness of the subject to inflammation.

Previous habits of the patient.—Habitual intemperance, and excesses of all kinds, enhance the danger of all serious attacks and accidents.

Extreme privations, or over-fatiguing employments, make people liable to fevers, and other depressing diseases, and reduce the powers of reaction against them; and the same remark will apply to close confinement and want of sleep.

Condition of the patient at the time of the attack.—Extreme weakness or exhaustion from any cause renders persons *bad subjects* for most diseases. Plethora increases the intensity of inflammatory affections. Simultaneous excitement of any organ, as of the brain from moral causes, may add a dangerous complication to continued fever.

620. *The cause of the disease.*—Epidemic, endemic, and infectious disorders, are chiefly serious in proportion to the intensity of their cause. Thus the endemic of a hot climate is more dangerous than that of a cold climate; an infectious disorder propagated in close habitations is more severe, from the concentration of its cause and co-operating influences, than one arising from more diluted and simple infection. By knowing the source of the disease, some estimate may be formed of its future severity.

The situation and nature of the disease.—The more important to life is the part attacked, and the more the disease interferes with its function, the more dangerous will it be. Thus the heart, the lungs, the medulla of the nervous system, the kidneys, and the blood, cannot be extensively attacked without great danger to life; and if the disease goes on to affect structure, as in inflammation, the danger is prolonged in proportion. In a few cases disease attacking an unimportant part, as the skin, or an extremity, may prove dangerous on account of its tendency to spread to other parts or infect the whole frame, as in the instance of cancer, gangrene, inoculated poisons, hydrophobia, &c.

The extent and progress of the disease.—The greater the extent of the disease, the more serious it will be in case of inflammation; but the severity of the symptoms is often not in proportion to its extent; intense and circumscribed inflammation causing more prominent symptoms than that which is extensive and diffused. The rate of the progress of disease most materially influences its effect on life and health. Thus the structure of the lungs, heart, kidneys, or liver, may become diseased to a most extraordinary amount, without destroying life, if the advance of the lesion is very gradual; whilst a third or fourth of the same mischief would prove fatal, if it were induced suddenly.

621. *The character of the symptoms.*—This is exhibited in the details of each disease. Those symptoms augur favorably which show a power of moderate and regular reaction, and a return of the functions to their natural state. The removal or alleviation of the more distressing symptoms of disease—the restoration of the natural appetites, and feelings, bodily and mental—the regaining of strength—the returning regularity and moderation of the pulse and other signs of equal circulation—the disposition to sleep tranquilly, and wake at the usual times—secretions that have been interrupted or diminished being restored, and often in increased quantity, as if from accumulation, as in the case of *critical* perspirations, deposits in the urine, &c. (§ 448)—are among the chief signs of approaching recovery.

622. Bad or unfavorable symptoms are those which arise from such

an impediment of one or more of the functions more immediately concerned in the sustenance of life, the circulation of the blood, respiration, nutrition, and excretion. In proportion as these functions are speedily and considerably impaired, life is threatened, and there is an approach to its destruction, by one or other of those terminations, which are called *modes of death*. Thus, there is death by *syncope*—cessation of the circulation; by *asphyxia*, or *apnœa*—interruption of the respiration; and by *inanition*. To these may be added, death by the *pernicious influence of excrementitious matters*, and by poisons, which cause death in various modes. These different modes of death are most distinct when induced so speedily as to leave the functions, which they do not directly affect, comparatively vigorous and outliving that which has been chiefly injured. Thus, in sudden death from causes stopping the respiration, the heart continues to act for some time, until the death which has begun with the breathing function reaches it also.

623. If we farther trace the operation of these different modes of death, we shall find that they all agree in affecting the blood, either by altering its composition or by arresting its circulation; and it is through one of these means that death extends to all the functions. Thus, in death by cessation of the heart's action, the circulation is at once arrested; hence this is the most speedy mode of death. Inanition obviously operates by reducing the circulating material, and by farther weakening the organs by which the circulation is carried on. Asphyxia we have already found (§ 235) both to impede the circulation and to alter the condition of the blood. Excrementitious matter retained in the blood, and extraneous poisons, also operate in various ways: by impairing the irritability of the heart; or by injuring the medullary nervous function (§ 154), on which respiration depends; or by arresting the passage of the blood through the capillaries (§ 298); or (and this probably includes some of the former modes), by so changing the properties of the blood itself, as to render it unfit for its office of sustaining the activity of the functions; and the operation of all poisons, as well as of other causes of death, may thus be traced to defective circulation or composition of the blood. It is the more necessary to keep these points in recollection, because they show why death from disease often takes place without distinctly beginning with any set of functions; but all fail from want of proper blood, their natural support.

624. It will be useful to mention the chief varieties of the modes of death above noticed, and to state their symptoms, which may become available as prognostic signs of the approach of death.

Death (cessation of function) beginning at the heart { Sudden=syncope. / Gradual=asthenia.
— — beginning at the breathing apparatus=Asphyxia, or apnœa.
— — beginning at the brain=Coma.
— — beginning at the medulla=Paralysis.
— — beginning in the blood=Necræmia (νεκρος, *dead*; αιμα, *blood*).

625. Death by *cardiac syncope*, or sudden cessation of the heart's action, may occur in two ways: 1. By this muscle losing its irritability (§ 116), so that it ceases to contract; and 2. By its being affected with

tonic spasm (§ 114), in which it remains rigidly contracted, losing its usual alternation of relaxation. In both these cases, death is quite instantaneous; the subject suddenly turning pale, falling back or dropping down, and expiring with one gasp. In the first case, both sides of the heart are found, after death, distended with blood; and if the examination were made soon after death, the blood in the left cavities would be found to be florid. In the second case, the heart appears small and very hard; the ventricles (or at least the left) are found so firmly contracted, that the cavity is almost obliterated, and contains no blood; the muscle is very firm; but after maceration in water, or even without it, in two or three days, the walls of the ventricles yield to the pressure of the fingers, and the cavities may be restored to their normal dimensions. This state of the heart was long mistaken for concentric hypertrophy, until Cruveilhier and Dr. G. Budd pointed out its true nature.

Although syncope by loss of irritability (paralysis) and syncope by spasm, appear to be opposite states, yet they arise from somewhat similar causes. In animals, wounds of the heart are followed sometimes by the one, sometimes by the other. Death by *shock*, as from tearing off a limb, a violent blow on the epigastrium, crushing the brain or spinal marrow, is sometimes caused by spasm, although more frequently by paralysis of the heart. In sudden death from drinking a quantity of raw spirits or of very cold water when the body is heated, the heart has been found contracted.

Syncope by loss of irritability of the heart is the more common case; and, besides, in the examples above given, it may be induced by the operation of large doses of certain poisons called sedative—such as the upas antiar, infusion of tobacco, aconite, and digitalis; and in combination with other effects, by large doses of hydrocyanic acid, strychnia, oxalic acid, arsenic, preparations of baryta, and various animal poisons. Mr. Blake found the power of the heart destroyed by solutions of various saline matters injected into the veins, especially salts of potass, magnesia, zinc, copper, lime, baryta, and lead; but these results do not correspond with what we find of the operation of these substances when introduced into the stomach.

The diseases in which death by cardiac syncope sometimes takes place, are—those of the heart (but more rarely than is commonly supposed); hemorrhagic apoplexy, attended with much injury to the substance of the brain (§ 364); anæmia (§ 270); and adynamic fevers (§ 105). As it occurs suddenly, there can scarcely be said to be symptoms; but sometimes an approach to it has been manifested in previous attacks of common syncope or faintness, in which the action of the heart becomes weak, irregular, and intermittent; and the partial failure of the circulation is evinced in the paleness of the face, lips, and general surface, often with cold perspiration; the failure of the sensorial functions (*defectio animi*), loss of consciousness and volition more or less complete, sometimes attended with various convulsive movements (§§ 153, 265); the eyes turning up or becoming fixed or glazed, and the pupils dilated. The different effects of posture on the forms of

syncope have been before noticed (§ 70); and they may be presented in cases in which cardiac syncope ultimately proves fatal. The recovery from this faintness is often attended with shivering, vomiting, sighing, gasping, yawning, and various distressing sensations of noises in the head, flashes in the eyes, palpitation, depression of spirits, &c.; whilst the pulse regains its strength and regularity, and the color and warmth return to the surface. After this may ensue a reaction, like that which occurs after great losses of blood (§§ 266, 362).

626. Death by the *gradual cessation of the heart's action* has been termed *asthenia* (α, *not*, σθενος, *strength*). This is the mode of termination of many diseases, especially those which destroy life by exhausting the strength, without any direct interference with the more vital functions. Thus long-continued fevers, delirium tremens, gastritis, enteritis, peritonitis, sometimes tetanus, hydrophobia, and inflammation of the brain—hemorrhages, and various discharges of animal fluids—such as diarrhœa, diabetes, extensive ulcers, or abscesses, &c., proving gradually fatal—inanition from want of sufficient food, and several others—reduce the power of the heart, and with it the functions of the whole body, to a lower and lower state, until at length the heart flutters, and dies.

The symptoms of the approach of death by asthenia are—increasing weakness of body and mind, whilst there may be no marked derangement of any particular function of either; increased frequency and diminishing strength of the pulse; the face, lips, and other parts of the surface gradually become paler and paler, or of a death-like sallowness; the extremities lose their warmth, and often become œdematous; the appetite fails; the tongue becomes sometimes dry and brown, sometimes furred, and the mouth aphthous (§ 483); the excretions first are imperfectly voided; then the sphincters lose their power (the weakness reaching their excito-motory function), and involuntary discharges of urine and feces may take place; and this state of *sinking* in a few hours terminates in death. The symptoms above described are those of progressive loss of power, not confined to the heart, but through its failure and that of the circulation of the blood, of which it is the chief instrument, becoming extended throughout the whole frame. But with this general debility there are often symptoms of partial excitement and reaction, which sometimes mark the sinking state. Thus a febrile excitement of a hectic kind (§ 471) may come on, giving slight temporary strength to the pulse, flush to the cheek, life to the eye, and a sort of flickering reanimation to the whole frame. Sometimes the excitement is more partial, affecting the brain, as with delirium; or the medulla, as with *subsultus tendinum*, hiccough, or other slight convulsion; or the stomach, as with vomiting, &c. Or, in the sinking state, some functions may become obscured before others, in consequence of congestions, effusions, or even low inflammations occurring in the capillaries of some organs (§ 290), as the powers of the general circulation fail. Thus the death by asthenia may become somewhat complicated with coma from congestion or effusion within the head; or with dyspnœa from congestion in the lungs; or somewhat similar symptoms may arise

from the early failure of the excreting organs, and the retention of excrementitious matter in the blood (§ 249).

627. *Asphyxia* or *apnœa* has already been noticed as an element of disease (§ 234), and its nature and symptoms were then examined (§ 235); we here advert to it as a mode of death. By *death beginning at the breathing apparatus*, I mean that in which the function of the apparatus is the *first* to fail. In this respect it is distinguished from death beginning at the brain or medulla, which destroys by *secondarily* suspending the function of breathing, and the distinction is useful for practical purposes as serving to direct attention to the most suffering organ. Death by simple apnœa takes place in diseases of the lungs and air-tubes, in which the entrance of air to the lungs is impeded by effusion into the air-cells or tubes; or by pressure upon them, as in bronchitis, pneumonia, pleurisy, &c.; by obstruction to the passage of the air through the trachea or larynx, as in croup, laryngitis, and tumors or spasm constricting these tubes; or in circumstances mechanically excluding the passage of air by the mouth and nostrils, as in smothering, strangling, hanging, and drowning.

The symptoms of the approach of this mode of death are—increasing feeling of suffocation or want of breath, which becomes most distressing and agonizing as the want is unappeased; the efforts at respiration are made in a hurried and forced manner; the face, neck, and other parts of the surface become congested in proportion to the violence of these efforts; and as these efforts are unsuccessful, the color of the congested parts changes from red to purple, and from purple to livid. The influence of this congestion and partial circulation of black blood (§ 235), is soon evident on the functions, causing stupor, reduction of temperature, weak and irregular pulse, rapid reduction of muscular strength, and consequently of the efforts to breathe. Hence the dark hue of the face may be changed to paleness; but the lividity of the lips, tongue, nails, and other colored parts, remains until death. In cases of speedy death from violence, as hanging, drowning, &c., or from a sudden attack of laryngitis or spasm, the respiratory efforts are more vigorous, and the congestion and lividity of the surface are greater, and may remain until death. But in the slower asphyxia from diseases of the lungs and air-tubes, the interruption to the breathing is less complete, the efforts are less violent, the congestion of the surface is less marked, and the functions more gradually failing together, the symptoms peculiar to apnœa are less decided. Hence, too, as imperfectly arterialized blood is circulated throughout the body, it may cause peculiar symptoms, such as stupor and low delirium, partial paralysis, vomiting, relaxation of the sphincters, and other symptoms of sinking. This exemplifies what has been before remarked (§ 622), that the distinctness of each mode of death generally depends on its speedy supervention.

As prognostic signs, the symptoms of apnœa are more hopeless in proportion as they are conjoined with those of debility. The nature of the obstruction to the respiration must of necessity be taken into account; and if this be not complete and irremovable, the congestion

and lividity of the surface are not fatal signs, so long as the strength of the breathing apparatus and of the heart does not decline; as this becomes exhausted, the means of recovery are lost.

628. Death by coma, or beginning at the brain, is caused by various influences which primarily destroy the functions of the superior masses of the nervous system. The chief of these circumstances are obstruction to the circulation through the brain by pressure (as of effused blood, pus, lymph, or serum, or of distended vessels in apoplexy, a depressed portion of bone in fractured skull, &c.;) by coagula within the vessels in anæmia (§ 267); and by various narcotic poisons, such as opium, alcohol in large quantities, carbonic acid or ether vapor inhaled (§§ 128, 246), and sometimes the excrementitious matter of urine and of bile in the blood (§ 249).

The symptoms of *coma* are those of interrupted function of the brain, insensibility and suspension of voluntary motion, the heart's action not being materially impaired. These may come on in different modes. In apoplexy and injuries of the head they may supervene suddenly, and the patient at once becomes powerless and senseless, the pulse continues pretty good, although slower and fuller than usual, or it may be frequent from mere sympathy. In other cases, the stupor comes on gradually, and the senses and mental powers are often irregularly obscured, causing dimness of sight, appearances of clouds or cobwebs before the eyes, *muscæ volitantes;* various imperfections of hearing, with noises, or *tinnitus aurium;* numbness and tingling sensations in the limbs; loss of memory, confusion of ideas, hallucinations, low delirium alternated with stupor (*typhomania*), continued somnolency, &c. Partial paralysis often accompanies progressively advancing coma, sometimes of the lower extremities (*paraplegia*), more commonly of one side (*hemiplegia*). In the operation of narcotics, the state of coma is commonly preceded by symptoms of cerebral excitement, manifest in the usual signs of intoxication and delirium, which vary in the case of different poisons. For these particulars, I must refer to works on toxicology and materia medica.

In conjunction with these symptoms, referable to the sensorial and voluntary functions, there are often symptoms of various affections of the excito-motory system of the medulla; at first, they are those of excitement, such as convulsion, vomiting, hiccough, contracted pupil, &c. (§ 152). Thus, the coma of apoplexy, and sometimes the stupor of narcotism, are occasionally accompanied by convulsions (§ 150), general or local; and I have elsewhere (§ 153) endeavored to explain how these opposite effects on different parts of the nervous centres may arise from the same cause. But in cases of more extreme coma, the excito-motory power of involuntary motions becomes impaired, the breathing is stertorous and imperfect, the actions of coughing and expectoration are not easily excited, deglutition becomes impossible, the pupils are not dilated, emetics fail to excite vomiting, the sphincters are relaxed, and involuntary discharges of urine and feces take place. The last group of symptoms was before noticed as the fatal part of coma and narcotism (§ 154).

It is a question whether the functions of the brain can be completely

suspended for any length of time without those of the medulla suffering also. During common sleep there is not complete insensibility or suspension of volition, for movements are then made in consequence of unpleasant sensations, yet without the sleep being broken. It is probable that in the trance of nervous subjects, of hysteric coma (§ 141), neither sensation nor volition is entirely abolished; but it is difficult to ascertain the truth in these cases, for the patients often deceive themselves as well as others. But in the heavy sleep of intoxication, and in the stupor of coma, in which pinching scarcely excites any evidence of consciousness, the functions of the medulla seem to be also impaired, for the breathing is slow and stertorous, and irritations of the nose and eyes less readily than usual excite the motions of sneezing and winking. It is in proportion as these functions are impaired that coma becomes dangerous; and it is because they are not impaired (and in some instances are distinctly augmented as manifest by the sighing and spasmodic twitching that occur) in nervous or hysteric stupor, that this is unattended with danger. It appears probable, however, that coma, when complete, may cause death by the abolition of sensation only, and if so, we are warranted in distinguishing between death by coma and death by paralysis of the medulla. Although the movements of breathing are ordinarily independent of the consciousness or will, yet such is not the case of the extraordinary movements which commonly take place in a deep breath or sighing; when the ordinary action is impeded by posture, fatigue, exhaustion or any other debilitating cause. Under these circumstances, when the function of the brain is unimpaired, the feeling of want of breath arouses a succession of voluntary efforts, which are manifest in suspirious breathing, and which are the cause of sleeplessness in delirium tremens, and other states of exhaustion (§ 154). But when sensibility and voluntary power are wholly suspended, these supplementary efforts are not made; for want of them, the respiration is insufficiently performed, and the lungs and air-tubes gradually become congested; this congestion and the resulting secretion farther impair the involuntary part of the process of respiration, and thus, without any indications of paralysis of the medulla, the signs and effects of apnœa are slowly superinduced on the state of coma. Under such circumstances, it is of great importance to place the patient in such postures or other circumstances, as shall most favor the movements of breathing, and remove pulmonary congestion by the proper remedies, should it arise.

Snoring arises from a relaxed state of the soft palate, and is of little moment so long as the movements of breathing are sufficiently strong and frequent; but when the respiratory powers are impaired, stertor is not only a sign but a cause of obstruction to the passage of the air, and should be prevented as much as possible by changing the posture of the patient.

The most dangerous kinds of coma, then, are those attended with symptoms of impaired excito-motory function, or those so profound and prolonged, as to deprive the respiration of all aid from voluntary efforts, the signs of danger being apparent especially in connection with the respiration. In apoplexy, contraction of the pupil of one or both eyes

is of very unfavorable import, because it indicates an excitement of the upper portion of the medulla, whilst the brain is oppressed; such a combination can only proceed from the partial operation of a clot in the substance of nervous centres, compressing one part and irritating another.

629. That death should ensue from *injured function of the medulla oblongata and spinalis* is quite intelligible, when it is considered that on this portion of the nervous system the ordinary act of breathing depends. This mode of death, like the last, is by apnœa; but the death, or failure of function, here begins with the nervous link of the chain of actions constituting the process of respiration; whereas in simple apnœa, it commences with the mechanism of the breathing apparatus.

This death may be called death by *paralysis*, and, as in other cases of paralysis of the excito-motory function (§ 144), it may be caused by suspended function, either of the nervous centre (medulla oblongata), or of the afferent nerves (par vagum and sympathetic), or of the efferent nerves (phrenic, intercostals, and spinal accessory), which complete the respiratory circle. Of influences which destroy the function of the medulla oblongata itself, may be mentioned, hemorrhagic effusion into its substance or upon it, fractures of the base of the skull, and any very considerable pressure on the whole encephalon. I have witnessed several deaths from encephalic hemorrhage, in which the stroke was not attended with loss of consciousness, and would not therefore be termed apoplectic, but paralytic, with loss of power of articulation, hemiplegia, and laborious and stertorous breathing which was obviously aided by voluntary efforts or struggles, the patient by gesticulations and violent gaspings, showing his consciousness of the failing respiration. In two such cases, in addition to some hemorrhage in one hemisphere of the brain, there was a clot in the pons Varolii. These cases establish the truth of the distinction between the death by coma and death by paralysis. Some poisons also seem to affect the medulla more immediately than the brain. Thus, animals poisoned with woorara, essential oil of bitter almonds, conia, belladonna, and perhaps some other poisons, are affected with gasping and other signs of impaired function of respiration before they lose consciousness; according to the experiments of Sir B. Brodie and others, they die simply from suspension of respiration, and if this process be artificially maintained for a time, the animals may sometimes recover from the effects of the poison. The same remark in some degree applies to opium and its active principle, but less distinctly, for these early induce coma, and often impair the action of the heart also. Experiments are wanting to establish the elementary operation of this and other poisons, as the functions are now viewed by physiologists. In some cases in which I have seen animals die from rapid hemorrhage, the respiration has ceased for some seconds before the heart's action; and from the peculiarly labored state of the breathing, and late retention of consciousness, I conclude that death from hemorrhage, in some instances at least, is due to suspension of the function of the medulla.

630. The division of the eighth nerves in the neck in animals illustrates one mode of inducing death by paralysis. These are the chief incident or afferent nerves from the lungs to the medulla, transmitting the impressions which excite the motory nerves of the muscles of respiration. When they are divided, the breathing is imperfectly performed, and expectoration and cough cannot take place; apnœa, therefore, gradually follows. Although we have not a result to the same amount exhibited in disease, yet we have an approach to it in the dyspnœa, sometimes constant, sometimes in paroxysms, caused by pressure of tumors on these nerves, or by malignant disease involving them.

631. The third mode in which the nervous link of respiration may be broken by injury to the excito-motory column of the spinal marrow or its branches, is exemplified in the case of breaking the neck, or dislocation of the upper cervical vertebræ. Pithing an animal effects the same thing. All parts supplied by nerves from below the injured portion of the medulla become paralyzed, and therefore their motions cease. Diseases in the vertebræ, in the spinal cord, or in its membranes, have been followed by similar results ; and the functions of the several nerves of respiration are illustrated by these cases. I have known disease affecting the cord at the upper cervical vertebræ cause loss of motion in all parts below the neck except the diaphragm, which is supplied by the phrenic nerve, and through which for awhile respiration was wholly carried on. The patient afterwards regained power in the spinal accessory nerve, by which he was enabled to elevate the upper part of the chest; and subsequently some power was for a time restored to the superior intercostal nerves and muscles.[1] In other cases, diseases of the spinal cord creeps from below upwards beginning with paralysis of the lower extremities and pelvis, then reaching the dorsal spine, palsying the intercostals, and at last reaching the neck. The advance or retrogression of all these symptoms are of great importance in the prognosis of such diseases.

632. Besides the respiratory functions, the functions connected with excretion are dependent on the integrity of the spinal cord; they fail when it is seriously injured, and this failure may furnish symptoms of death, beginning at the spinal cord. When the cord is injured only at a point, and remains healthy above and below it, the injury may merely intercept the transmission of sensation upwards, or of volition downwards beyond the injured point. Hence, there may be loss of sensation, or of voluntary motion, or of both, in the lower portions of the body. If this reach the urinary apparatus, the power of spontaneously voiding urine is lost. But the reflex or independent excito-motory influence of the spinal cord remains; hence, the sphincters and the bladder retain their power, and when the catheter is introduced into the bladder, it contracts as usual, aided by the voluntary power remaining in the diaphragm and abdominal muscles. We have before noticed (§ 149) that, under these circumstances, the muscles of the lower extremities retain and accumulate their irritability, and although the will has no command over them, yet tickling, or even touching

[1] Med.-Chir. Trans. 1843.

them, may excite them to contract with unwonted energy (§ 141). The exercise thus kept up seems to be sufficient to preserve their nutrition, for they do not waste away.

But it is quite different if the spinal cord be extensively injured, as by crushing, softening, or a considerable effusion of blood or pus into its sheath. Its function then ceases, not only as a communicator of sensation and voluntary power to the lower parts of the body, but also as a source of that involuntary excito-motory power by which the sphincters contract and the urinary bladder evacuates its contents. Hence, there is constant dribbling of urine, yet without the power completely to empty the bladder. The feces are discharged unconsciously, and without the power of control. The limbs are not only insensible and powerless to the will, but their muscles can no longer be excited by tickling; they lose all motion, and the bloodvessels lose that influence which the nerves of all orders exercise upon them. It is not surprising, under such circumstances, that the death which has begun in the spinal cord should spread to the parts whose functions it can no longer maintain. The urine, imperfectly discharged, putrefies, and causes inflammation of the bladder, which may gradually extend to and stop the function of the kidneys. The intestines become distended and obstructed with gas and pent-up feces. The limbs lose their proper circulation for want of motion and nervous influence in their muscles and vessels; their nutrition fails, they become œdematous, partially inflamed, livid, and run into gangrene; and all these changes are so many signs of the progress of death which has begun in the spinal cord.

From the remarkable effect of cold and some poisons on some of the lower animals, inducing paralysis of the hinder extremities, it is probable that these agents are capable of especially injuring the function of the spinal cord, beginning with the remote part. Has the gangrene of the lower extremities, sometimes induced by the use of ergotted corn, any connection with an injured function of the spinal cord?

Death of the medulla supervenes on that beginning with coma and asthenia in many cases; and as its involuntary excito-motory function is the guardian of many processes essential to life, the symptoms connected with it are of great importance in connection with prognosis. (See § 154.)

633. *Necræmia, or death beginning with the blood*, are terms which I venture to give to those fatal cases in which the chief and most remarkable change is exhibited by the blood. In typhoid fevers and others of the malignant or pestilential kind (§ 105), none of the solids of the body constantly exhibit such an early change of function or of structures, as would warrant us in tracing disease and death to them. It is true, that the functions of many solids are impaired—the muscular and nervous systems, secretion, digestion, assimilation, and nutrition, all suffer, but the very universality of the affection seems itself to point to some cause more general than can be found in any individual func-

tion; and such a cause may be found in the blood. The blood, at an early period of these diseases, when they occur in their worst form, exhibits changes which show that disorder begins with it, and this disorder may reach to a fatal degree. The appearance of petechiæ and vibices on the external surface, the occurrence of more extensive hemorrhages in internal parts, the general fluidity of the blood (§ 196), and frequently its unusually dark or otherwise altered aspect (§ 186), its poisonous properties as exhibited in its deleterious operation on other animals (§ 259), and its proneness to pass into decomposition, point out the blood as the first seat of disorder, and by the failure of its natural properties and functions as the vivifier of all structure and function (§§ 182, 263), it is plainly the medium by which death begins in the body. How far the change in the blood is in its structure (§ 189) and vital properties (§ 211), or in its chemical composition (§ 181), farther research alone can determine; the vivifying function of the blood depends on all these combined, and it is this function which obviously fails. Hence, the complete adynamia, or general prostration of all living powers, which occurs where this cause of death is most powerful. The blood, the natural source of life to the whole body, is itself dead, and spreads death instead of life. Almost simultaneously, the heart loses its power, the pulse becoming very weak, frequent, and unsteady; the vessels lose their tone, especially the capillaries of the most vascular organs, and congestions occur to a great amount (§§ 290, 293); the brain becomes inactive, and stupor ensues; the medulla is torpid, and the powers of respiration and excretion are imperfect; voluntary motion is almost suspended; secretions fail; molecular nutrition ceases; and at a rate much more early than in other modes of death, *molecular* death follows close on *somatic* death—that is, structures die and begin to run into decomposition as soon as the pulse and breath have ceased; nay, a partial change of this kind may even precede the death of the whole body (somatic death—Dr. Pritchard);[1] and the fetid aphthous patches in the throat, the offensive colliquative diarrhœa of persons in the last stage of various fatal diseases; parts running into gangrene, as in the carbuncle of plague, the sphacelous throat of malignant scarlatina, and the sloughy sores of the worst forms of typhus, and in the large intestines in dysentery, and the putrid odor exhaled even before death[2] by the bodies of those who are

[1] See Dr. Symond's interesting essay on "Death," in the *Cyclopædia of Anatomy and Physiology*.

[2] Certain anecdotes, usually considered to be superstitious, derive some probability from the above-mentioned facts. It is said that some of the lower animals, especially dogs and rats, have an instinctive foreknowledge of the approach of death in a house. I have known two instances, in which for two days before a death and until the body was removed from the house, rats from the drains infested the basement of the house in a degree never approached before or since. It is possible that a deathy odor [of which some sensitive persons profess themselves conscious] may be perceptible to the acute olfactory organs of these animals; or perhaps a more substantial cause of attraction may be presented in the putrid excrementitious discharges thrown down the drains under these circumstances; and this notion may give some countenance to the still more marvellous assertions generally made by sailors, that sharks will pertinaciously follow a ship that bears a dying man or corpse.

the victims of similar pestilential diseases—are so many proofs of the early triumph of dead over vital chemistry.

634. We have hitherto represented an extreme case; but there are many lower degrees in which disease begins with the blood, and various disturbances and reactions result. The causes which appear thus primarily to affect the blood are especially endemic, epidemic, and infectious influences, called poisons (§§ 81, 88, 93), certain animal and vegetable poisons, as that of the most venomous reptiles and fungi, and probably some mineral poisons, as sulphuretted hydrogen, selenium, and, in part of its operation, arsenic. The direct influence of all these agents is depressing (§ 105), and when they operate in large quantities, or in a concentrated form, the vital powers fall quickly into a state of adynamia or prostration, which soon ends in death, as we have already described it, the blood first and most constantly manifesting a change. But if the noxious influence is in smaller quantity, or more diluted, the vital powers react against it (§ 16) in various ways, the object of which can often be plainly discerned to be its expulsion from the system. The shivering, hot stage, and sweating termination of paroxysms of intermittent fever; the similar but less marked series of febrile movement which occur in slight forms of remittent and continued fevers; the profuse and violent fluxes from the stomach and intestines in cholera, dysentery, and epidemic diarrhœa, and the similar discharges induced by poisonous ingesta, are instances of the operation of vital reaction attempting the expulsion of the noxious matter, and of that part of the animal fluids that had been corrupted by it. But these struggles in many instances constitute serious diseases, in which life may be compromised by the violence and exhausting effect of the reaction as much as by the prostrating influence of the cause of the disease; in these more complex affections, individual organs may especially suffer in different cases, and the danger and cause of death may be less in the changed condition of the blood than in the affections of particular organs, or the exhaustion consequent upon them, which destroy, not by necræmia, but by coma, asphyxia, or asthenia, modes of death already considered.

635. The injurious effect of these poisons may be still more completely prevented when their quantity is small and the living powers are vigorous. A diarrhœa, a profuse sweat, or a free flow of urine, sometimes carries off the commencing disease. The intestines, the skin, and the kidneys, appear to be the proper emunctories through which morbid matter is expelled. The peculiar fetor of the secretions from the bowels in typhoid fever, the beneficial influence of moderate diarrhœa, which removes them in the early stage of fever, and appearance of a foul fibrinous matter (typhus-material of German writers), in the intestinal glands, seem to be examples of the elimination of a morbific matter; and I have before suggested (§ 404, *note*), that the follicular inflammation, ulceration, and sloughing of the intestines in fever may arise from the excessive irritation of the follicles in the exercise of this eliminating function. Again, with regard to the kidneys, it has been before mentioned, that granular degeneration, which impairs their function and power of elimination, renders the body peculiarly liable to contract epidemic and

infectious diseases, and to succumb under them (§ 260).[1] This renders the prognosis unusually unfavorable in these cases. The same remark extends and for the same reasons, to persons who have been habitually intemperate. On the other hand, those whose kidneys are naturally active, more effectually resist disease, and more readily throw off its effects (§ 448). In like manner, it is well known that persons with a naturally dry skin do not so readily get rid of a fever as those in whom perspiration is readily excited.

636. Besides the influences already mentioned (§ 634), as first attacking the blood, and in extreme cases injuring its composition and causing its death, there are others originating in the body itself. Thus the processes of gangrene and suppuration sometimes infect the blood with a septic poison (§§ 470, 475), and cause death in a manner and with symptoms like those of the poisons above noticed. The sudden suppression of the excretions of urine or bile, from disease, or under the influence of any severe shock, also seem in some cases to operate by injuring the properties of the blood; whilst in other instances it distinctly induces coma or asthenia. We have before adverted to retention of excrementitious matter as a cause of *cachæmia*, or depraved state of the blood (§§ 249, 564); so we now find that, in an extreme degree, it may cause *necræmia*, or death of the blood.

637. The symptoms which should make us apprehend the approach of death by necræmia may be gathered from the preceding descriptions. Those symptoms generally called typhoid, putrid, or malignant, belong especially to this class of deadly influences. For example: a congested appearance of the whole surface, the color being dusky or livid, and extending to the conjunctiva, tongue, and fauces; various slight exanthematous or papular patches on the skin, often with petechiæ; more extensive hemorrhages in form of ecchymoses, or oozing of thin bloody fluid from the gums, nostrils, and sometimes from other passages; extreme prostration of strength, with an obtuse state of all the senses and mental faculties, sometimes combined with delirium and twitchings of the limbs; half-closed eyes and dilated pupils; a very frequent, weak, and soft pulse; frequent and unequal respiration; no appetite; intense thirst, a dry, brown tongue, with dark sordes on the lips and teeth; a progressive fall of temperature, which may have been elevated at first; often cold, clammy, and fetid perspiration; hiccough; subsultus tendinum; scanty, offensive urine; involuntary discharges.

Some diseases of the same class are modified by peculiar effects. Thus in malignant cholera, excessive discharges of serum, by vomiting and by stool, reduce the blood to such a spissitude, that it will no longer circulate through the vessels; the pulse ceases, and the surface becomes blue and cold from the darkness and stagnation of the blood, and shrunk from the exhaustion of its fluids. In yellow fever, altered

[1] This was exemplified in the case of an epidemic erysipelatous angina, which attacked several patients of the University College Hospital, in the spring of 1843. Out of about a dozen cases in which persons affected with various diseases were attacked, three died from the erysipelas extending to the larynx, and in all these the kidneys were granular and the urine albuminous.

blood is ejected from the stomach in the form of what is called black vomit. But to pursue this subject into farther details belongs rather to the department of special pathology.

638. It has been before mentioned, that the complete distinction of these different modes of death is almost exclusively confined to cases of speedy or sudden death. In the slower dissolution, by which diseases generally prove fatal, all functions and structures are more or less involved; and the life in all is dwindled down to so slight a thread, that when it breaks in one, others scarcely retain it long enough to enable us to say that death begins distinctly in any part.

[A brief sketch of some of the most common symptoms influencing our prognosis, will not, perhaps, be here without value.

Much may be inferred from the general aspect of the patient. Constant change of position, unimportant in the beginning of acute diseases, becomes alarming when it persists for any time. Lying continually in the same position, as constant dorsal decubitus, in low forms of disease, is a very bad symptom. Inability to lie down, which sometimes happens in thoracic disease, is equally sinister. Jactitation succeeding to quietude, in the latter stage of acute disorders, is generally a mortal sign, especially when accompanied by an attempt to throw aside the bedclothes, and ineffectual efforts to rise.

Progressive emaciation in acute affections is of little importance, but in chronic disorders it should lead us to anticipate a fatal termination in proportion to its rapidity. General œdema is of extremely bad augury. The occurrence of sloughs in various parts of the body, in both chronic and acute disorders, is a very bad sign. The physiognomy should be especially studied in reference to prognosis. When the natural expression of the countenance is preserved, it is always of favorable import. Great alteration in the features in the commencement of an acute disorder, ought to make us fear, about the fifth or ninth day, the supervention of low symptoms. In the advanced stage of all diseases, a sudden and great alteration in the physiognomy announces approaching dissolution. When it occurs at a period where a fatal termination is not to be anticipated, it should lead us to suspect the development of some acute affection, the enfeebled state of the patient not admitting of its exhibiting the ordinary local symptoms; a sudden aggravation of the general symptoms being the only indication. It generally announces death in less than three days. This change of countenance must not be confounded with the pallor which marks the commencement of convalescence in fever, etc.; the accompanying phenomena serve to distinguish them. Subsultus, trembling, and rigidity, always mark danger. Carphologia, epileptic and tetanic convulsions, rigidity of the limbs, are mortal signs in the advanced stages of fever. Another invariably fatal symptom, according to Chomel, is the automatic movement by which the patient seeks to approach his hand to his body, whilst the physician is feeling his pulse. Aphonia is a bad sign in acute disorders. The intensity of pain, by no means, in general, indicates the amount of danger. *Cæteris paribus*, deep-seated pain is more unfavorable than that which is superficial; and that which is

fixed more so than that which is variable. The sudden cessation of pain in inflammation, joined to great alteration in the features, indicates approaching death. According to Chomel, suppuration, not gangrene will be found, under such circumstances, on examination. Deafness is a sympathetic phenomenon occurring in many acute diseases, and is always serious. In the mortality of typhoid fever, if a comparison be made of those who suffered from deafness in the course of the disease and those who did not, the deaths among the former will be found as two to one among the latter (Chomel). Hope and cheerfulness are generally good signs. Distrust and despair are very unfavorable symptoms. It is rarely that patients who have the persuasion that they will die, recover, unless they are hypochondriacs. Total indifference is a bad sign. In several chronic disorders, the tranquil security enjoyed by patients does not diminish the gravity of the prognosis.

The prognostic signs furnished by delirium are connected with its intensity, persistence, and the conditions under which it occurs. Mild delirium, soon passing off, is not serious; permanent delirium always is. Many persons, of all ages, are liable to delirium whenever they are attacked with ephemeral fever, or an angina; it is only necessary to be aware of the idiosyncrasy in order to appreciate the value of the symptom.

Prolonged sleep in the course of fevers is not dangerous if the patient be readily aroused. Coma is alarming and nearly always mortal, when intense and permanent.

The sudden occurrence of a voracious appetite announces speedy death (Baglivi). Chomel has frequently met with this symptom in pneumonia; death soon took place. Dysphagia is generally a mortal symptom in cerebral and acute disorders.

The signs which the respiration furnishes prognosis are important and rarely deceive. A hurried respiration indicates great danger. When the number of respirations amounts to fifty in the minute, it may be generally stated that death will soon follow. The tracheal rattle and stertorous breathing are usually precursors of dissolution, especially when they occur towards the latter stages of cerebral disease. In inflammation of the lungs stertor is not alarming so long as expectoration takes place. Paroxysmal is less dangerous than permanent dyspnœa. Hiccough is a very unfavorable symptom in the latter stages of disease, unless it is accompanied by a notable amendment in the other symptoms.

The pulse furnishes few but important symptoms. A pulse of moderate frequency and force is favorable. Considerable frequency of pulse indicates something serious. A pulse of 150 in an adult should lead to a very unfavorable prognosis. If at an advanced period of any affection the pulse becomes irregular or intermittent, or ceases, death is near.

Augmentation of the heat of the body is of bad import, especially when dry. Sudden chilliness of the extremities and rest of the body occurs usually a short time previous to dissolution. Chills at an advanced period of the disease, should lead to the suspicion of the formation of pus, or of its resorption, according to circumstances. Abund-

ant sweating towards the close of a disease is a favorable sign. Cold sweats at the same period are generally unfavorable.

Hemorrhages at the beginning indicate usually that the disorder will be serious. Towards the close they are either favorable or unfavorable. Epistaxis, the hemorrhoidal flux, and metorrhagia, are generally favorable signs in those who are liable to them. Hemorrhages from the lungs and intestines are usually mortal; those from the urinary organs nearly constantly fatal.

The degree of strength which the patient possesses is of great importance in forming a prognosis; considerable diminution or perversion is always dangerous, especially in the early stage of the disease.—C.]

CHAPTER VII.

PROPHYLAXIS AND HYGIENICS.

639. *Prophylaxis* is the guarding against a particular disease; and *hygienics* relate to the prevention of diseases in general, or to the preservation of health. The former is connected with special rather than with general pathology; and it should be founded on a due knowledge of the causes, nature, and tendencies of diseases, and of the various means in diet, regimen, residence, and medicine, which are capable of removing the causes of disease, or of preventing or counteracting their operation.

640. *Hygienics*[1] consist in the knowledge and application of those means, by which the structures and functions of the body may be kept in that normal state which conduces to their continued welfare—that is, in *health* (§ 6). We have found, that both structures and functions have the elements of disease in themselves, when anything disturbs their due proportion. We have noticed the circumstances which lead to such disturbance, both in connection with the causes of disease (under the head *Etiology*), and in connection with its intimate nature (in the division *Pathology proper*); and remarks on the medicinal and hygienic means of preventing or counteracting those circumstances were introduced in the context to a sufficient extent to suggest the principles of hygienics. It will be sufficient in this place to consider briefly the chief corresponding circumstances which promote the maintenance of health, and these may be arranged under the following heads: *Food; Clothing; Temperature; Air; Exercise; Mental Occupation; Sleep*, and *Excretion*. The nature of this work precludes many details on these important topics, and the following is intended as a mere outline in conformity with the principles previously explained.

[The object of hygiene is the preservation of health and the prevention of disease; and hygienics include everything which tends to accomplish these ends. Although hygiene has been called the medicine of healthy individuals, it is still applicable and even indispensable to invalids, and is often of more service to them than medicine itself; for whilst the efficacy of many remedies may be doubtful, the propriety of hygienic measures is universally admitted. By their aid alone, without a resort to the materia medica, the majority of acute disorders will terminate favorably; without them our best directed efforts will often prove

[1] I use this term (derived from the Greek ὑγιεινικος, relating to health, and analogous to *optics*, *acoustics*, &c.) as more conformable to our language than the French term *hygiène*.

unavailing. We frequently see patients in bad hygienic conditions, perish in spite of able physicians, and an abundance of remedies, and the mildest diseases converted into mortal ones from similar reasons. The crowding of patients into narrow, ill-ventilated places, the contamination of the air, the absence of cleanliness, the want of suitable clothing, exposure to cold and wet, errors of diet, mental depression, fatigue collectively, invariably produce terrible effects; whilst in a large number of acute affections of the severest kind, recovery occurs without a resort to any active remedy, merely under general hygienic measures. —C.]

FOOD.

641. The purpose of food being the supply of materials, which, when prepared by the process of digestion, shall repair the waste of the body and maintain its temperature, it is obvious that this purpose will be best fulfilled when the materials supplied are of such quality and quantity, and so administered, as to suit respectively the powers of digestion and the wants of the system for nourishment and warmth; in other words, food should be digestible, nutritious, and calefacient, and the articles which duly comprise all these qualities will be the most wholesome food.

642. The importance of a due combination of the chief alimentary principles, albumen, oil, sugar, or starch, with water as their diluent, has been before pointed out (§ 58); and the expediency of preferring such materials as comprise these in the best quality or condition may also be inferred from preceding observations (§ 60).

[A diet exclusively animal produces constant stimulation of the alimentary canal, augments thirst, and is accompanied by constipation; the alvine excretions being hard, dark colored, and small in quantity. The natural temperature of the skin is augmented, the pulse is in general frequent and quick, and there is emaciation. The blood is modified by a diminution in its aqueous constituents, whilst the proportion of globules and of fibrine is increased. The urine is scanty, contains much solid matter, is somewhat dark colored, and very acid; being highly charged with urea and uric acid. This regimen is adopted by the inhabitants of cold climates, and those who are particularly addicted to violent muscular exercise. It is thought to generate the requisite amount of animal heat to enable them to resist a very low temperature. Such a regimen in temperate climates, if long continued, causes inflammatory disorders, which the increase in the amount of fibrine in the blood adequately accounts for.

A diet exclusively vegetable is certainly less injurious to health, and this result is probably due to most vegetables containing nitrogenized matters, as vegetable fibrine, albumen, and caseine. If a regimen exclusively vegetable be continued for any length of time, it invariably causes a languid and feeble state of the digestive system; the act of digestion being protracted and painful, and accompanied or followed by the development of gas. The feces are abundant, light-colored, often semiliquid, and diarrhœa is not infrequent. The temperature of

the body is low, and easily falls; the constitution is feeble, and there is but little bodily vigor. During the use of an exclusive and abundant vegetable diet, obesity is very apt to be developed, especially if but little exercise is taken. Many disorders may be developed as the consequence of such a regimen. 1. By the impoverishment of the blood, from the simultaneous and proportional diminution of the red globules, albumen, and fibrine, anæmia or dropsy may follow. 2. Gastralgia, flatulent dyspepsia, diarrhœa, &c. 3. Entozoa are often the consequence of vegetable aliment in excess. 4. Diabetes is generally regarded as one of the results of the exclusive use of fecula; the large quantity of sugar produced by the liver not being burnt by the oxygen absorbed in the act of respiration, a portion passing unchanged into the arterial current, from which it is excreted by the kidneys.

A mixed diet, composed of a moderate and determined quantity of animal and vegetable substances is that best adapted to the inhabitant of temperate climates. According to M. Dumas, a man in good health, and of ordinary appetite, should consume in the 24 hours 154 grammes of carbon, and 225 of nitrogen; the following quantity of corresponding articles of food he proposes for a cavalry soldier.

	Weight. Grains.	Nitrog. matter. Dry.	Non-nitrog. matter. Dry.
Fresh meat . . .	125	70	
Camp bread . . .	750	64	595
White bread . . .	516		
Vegetables . . .	200	20	150
	1591	154	745

The proportions of nitrogen contained in different vegetables may be represented, according to M. Boussingault (the quantity of this principle contained in wheaten flour being 100), by the following equivalents: rice 77, peas 67, lentils 57, beans 56.—C.]

It may not be superfluous to exemplify these points farther by a few comments on common articles of diet.

Wheaten bread comprehends the albuminous (gluten) and the amylaceous principle, and only needs the addition of butter to complete the requisite combination for moderate nutrition. The goodness of bread depends not only on the character of the grain from which the flour is obtained, but also on the mode and degree of its fermentation and baking. If fermented with leaven instead of yeast, or if overfermented, acetic acid is generated and the bread is sour, and this is the common fault of bread in large towns where the supply of yeast is insufficient, and it prevails universally on the Continent. This evil is avoided in the unfermented bread, which is rendered porous by an effervescence of carbonic acid gas, caused by an admixture of carbonate of soda with the flour, and hydrochloric acid with the water, of which the bread is made; when well prepared such bread is very sweet and free from acidity, but unless carefully prepared is liable to be heavy, and like imperfectly fermented bread it is then unfit for mastication. Bread insufficiently baked is glutinous and indigestible, and much of the same objection applies to quite new bread which has not dispersed its moisture. These defects may in great measure be remedied by toasting the

bread in thin slices, which has also the advantage of dispersing much of the acid from sour bread. Very white bread is objectionable as being less nutritious (having less gluten) and more constipating than that made with less refined flour; but the coarse material commonly sold as brown bread errs to an opposite extreme, in containing a bran so coarse as to be irritating to many stomachs. Good country bread fermented with yeast, and well baked, presents the kind most generally wholesome.

Meat comprises the albuminous, oily, and gelatinous principles, besides creatine and other soluble extractive matters, which are probably nutritious. It requires combination with vegetables or bread to make it suitable to the palate and stomach. The object of keeping and cooking meat is to make it so tender as to be easily softened by the gastric juice, and all processes which interfere with or go beyond this result, render meat less wholesome. Thus salting or pickling, keeping until it becomes tainted, or hardening it by overcooking or fast boiling, which corrugates and toughens the fibre, are so many means of spoiling the meat for the purposes of digestion, and rendering much of its nutriment unavailable. The flesh of young adult animals presents the greatest amount of fibrinous nutriment; that of younger animals contains more gelatine and fat; and that of older age is tough from the prevalence of fibrous textures, which being gelatinous are more serviceable for soups. The kinds of animal food vary much in their composition, even when the lean parts only are selected. Thus beef and pork contain a large proportion of fat; mutton somewhat less; veal still less; and in the flesh of fowl, game, and white fish, there is only a small amount. This affords an explanation of the fact that the latter articles are the best suited to persons of weak stomach. But the proportion of creatine and colored extractive doubtless also determines the quality of the food; thus the flesh of hare, which contains much, is more heating than that of chicken and whiting or sole, which may be taken as the representatives of the mildest form of solid animal nourishment. Soups and broths, when deprived of excess of fat, are very useful articles of auxiliary nourishment in combination with solid food, but they are not substantial enough to supply a meal to a healthy person. Eggs and milk respectively, separately or combined, form light and nutritious articles of animal diet. They are rendered easier of digestion by being heated to about 180°, by which part of the albumen is slightly coagulated. Both eggs and milk contain a considerable amount of oil, which causes them, when taken too freely, to disagree with persons of bilious habit. So likewise, they are prone to speedy decay, and lose much of their wholesome nature, even in a day or two. In like manner, fresh butter is an excellent adjunct to bread and vegetable articles; but speedily becomes rancid and loses its salubrious properties. Cheese is a low form of proteine compound, which requires energetic digestive and assimilating powers to raise it to the higher standard of the material of the plasma of the blood; it is therefore wholly unfit for delicate persons and those of weak digestion.

Oleraceous and succulent vegetables and fruit are fit adjuncts to the more nutritious articles of food, which they serve to dilute; and by the

subacid and extractive matter which they contain, they promote the secretions, and thus tend to purify and cool the blood. In most instances they require to be thoroughly cooked to give them the state of softness fit for the digestive process.

643. The choice of food and the arrangement of hours for different meals must vary much according to the habits and necessary occupations, as well as the strength and tastes of individuals; but the following plan of diet, with some variations, will be found well suited to the majority of healthy adults.

Breakfast at from eight to nine A. M., of bread or dry toast with a moderate quantity of butter. One or two new laid eggs, boiled three minutes and a half; or a little cold chicken or game, or even a mutton chop, may be added for those who use much bodily exertion. Beverage, one breakfast-cupful of *café au lait;* that is, clear strong infusion of coffee with scalded milk, in proportion of one-third of the former to two-thirds of the milk. Cocoa, deprived of fat, or thin chocolate with milk may be substituted.

Luncheon at from one to two P. M., may consist of a small basin of good shin of beef soup, with vermicelli, rice, or toasted bread in it. If meat have been taken at breakfast, a biscuit or piece of bread and butter, or small sandwich may suffice for luncheon; wine and malt liquors are generally better avoided at this time, unless dinner be taken at this hour.

Dinner at from five to seven P. M. (The latter hour is not recommended, but is often unavoidable.) Wholesome fresh meat and vegetables, well but plainly cooked, served hot, carefully proportioned, properly masticated; varied from day to day, with simple additions of fish, and moderate quantities of farinaceous or fruit puddings. Highly seasoned dishes, pickles, salted and dried meats, rich and heavy pastry, and cheese, except as a mere relish, to be excluded from a table professing wholesomeness. Beverages: sound white wine (sherry or good Marsala, from one to three glasses), which is generally better mixed with water; or sound Sauterne or Moselle unmixed.

[In this country, particularly during the summer season, a small portion of sound claret, mixed or not with water, according to the habits and constitution of the individual, is a preferable beverage during dinner, than the strong and stimulating Spanish wines, which may be better borne in the moister climate of Great Britain.—C.]

Those who use much exercise may substitute sound malt liquor, bitter ale being the lightest, and good porter or stout the more sustaining. Half a pint is generally as much as is good for the health. Many thrive well, especially in the country, without any fermented liquor. If water is taken it should be in moderation, otherwise it may interrupt digestion. Some find warm water, or milk and water a pleasant beverage. The habit of taking wine after dinner is one of luxury, not of health, and all that can be said of it in hygienic instructions, is—the less the better. The practice of taking a little fruit at the same time is not equally hurtful, provided by its quality or quantity it do not excite indigestion.

[A small cup of a strong infusion of coffee, without the addition of

milk or cream, taken *immediately* after dining, undoubtedly promotes digestion. Nervous persons, and those suffering from dyspepsia, gastralgia, &c., should not adopt this custom. Those habituated to the use of coffee in this manner often suffer serious inconvenience from its disuse, the most common one being severe and constant congestive headaches. A cold infusion of coffee, prepared without cream or sugar, is a most wholesome beverage.—C.][1]

Tea.—The English custom of taking tea, or a simple warm liquid meal three or four hours after dinner is a very salutary one, and probably disagrees only with those who dine too late, or overload the stomach at dinner. The purpose of the warm liquid is to assist in the separation and absorption of the chyle from the chyme, which takes place at this period. And it is obvious that it would interfere with this process to introduce solid food into the stomach; therefore, little or nothing should be eaten—certainly not quantities of buttered toast, rich cake, and the like. Two or three moderate cups of black tea with a little milk and sugar, forms as a wash to the stomach to carry away the taste and smell of dinner, and remove all acrid materials, left by digestion, which might disturb that rest for which the hour now approaches.

644. The practice of dining early, at from one to three P. M., which is pursued by the majority of persons in the lower and middle ranks of society, would deserve more general adoption on the score of health, were it not generally impossible then to devote the time to it, and to rest after it, that the principal meal requires. A hurried early dinner, if enough to satisfy the appetite, is pretty sure to cause indigestion, and disqualifies for exertion afterwards. If, on the other hand, it be purposely made light, it may not suffice for the wants of the system, and an evening meal or supper will be necessary. The chief objection to suppers is that they are indulged in either so freely or at so late an hour, that their primary digestion is not accomplished by bedtime. Hence flatus and other symptoms of indigestion occur on lying down, and may prevent or disturb sleep, and the individual rises on the fol-

[1] [In moderate quantities, varying with different individual susceptibilities, coffee is an energetic and special nervous stimulant, and frequently produces insomnia. In larger doses it is slightly narcotic. Its action is general, it determines no local heat and stimulation in the epigastrium, but the circulation is accelerated, the animal heat augmented, the secretions and excretions increased, and the whole organism gently excited and revivified. Its power of developing animal heat, renders it the proper stimulant to be taken by those who are much exposed to the vicissitudes of climate. It is eminently nourishing. In an interesting communication made by M. Gasparin, to the French Academy of Sciences (March, 1850), some very curious statements were made respecting the part coffee plays as a nutritive agent. Starting with the generally admitted fact, that the quantity of nitrogenized matter contained in the daily food necessary for the sustenance of a healthy adult male may be estimated at from 20 to 26 grammes; and having noticed that the miners in the neighborhood of Charleroi were well nourished, strong, and of great muscular development, and under a quotidian regimen which contained but 14.82 grammes of nitrogenized matter, and which was inferior to that permitted in the strictest conventional societies, that of La Trappe, for example, he was led to the conclusion that their most thriving condition under this amount of food was due to the free use of coffee, in which they indulged. As the positive amount of nutritive material it contains is but small, 1-35th, was this effected by increasing the powers of assimilation, or by retarding the destructive processes of the economy, thus rendering the amount of necessary reparative aliment less? This is still an open question.—C.]

lowing morning with a pasty mouth and unrefreshed. To avoid these consequences, the supper should be taken at least two hours before going to bed; and should consist of such light nourishment as is easy of digestion, not too bulky, and not disposed to generate flatus. Those who use much exercise may take with advantage a little light meat, chicken, game, white fish, or lightly dressed eggs, with a small quantity of wine and water, or sound beer (if this do not disagree). Those who require less sustaining food, as sedentary, plethoric, or inflammatory individuals, will find a more suitable supper in a light farinaceous pudding, bread and milk, or oatmeal porridge; the last being especially useful in persons of costive habit. A few currants, raisins, or a little apple with farinaceous puddings counteract their constipating tendency.

A habit of regularity in the hours of meals is of great importance in the preservation of health. The stomach acquires the habit of expecting and the power of digesting food at regular intervals, and various disturbances in its function and in the system result from irregularity. For this reason it is much better for those who cannot always dine early, to keep regularly to the late hour. The evil effects of long fasting are partly dependent on the infraction of this rule; but some result from inanition, which has been noticed under the head of causes of disease (§ 63). Few delicate persons can bear much exertion of body or mind before breakfast; the practice of an early morning walk is only suited to the robust, who feed largely and late on the preceding day. When it is borne in mind that food is intended not only to supply the slower process of nutrition and reparation of the body, but also to afford materials for the immediate protection of the blood against the chemical action of the oxygen absorbed in respiration, and of the stomach against the chemical action of the gastric juice—the injurious tendency of long fasts will become apparent, and the more so in proportion as the small capacity of the digestive powers limits the quantity of aliment taken at a time.

CLOTHING.

645. The acknowledged purpose of clothing, as means of preserving the health, is to maintain as much as possible such an equal warmth of the surface and extremities of the body, as may conduce to the comfort of the feelings, and promote a free circulation, with sufficient perspiration and innervation in all the external parts of the body. But the healthful operation of clothing is not confined to its property of retaining warmth. It is useful also in protecting the body against the injurious influence of external heat, dryness, moisture, and electricity; and varied modifications of the clothing will best answer these several ends under different circumstances.

The lower animals exhibit many interesting facts showing instinctive or natural provisions for changes in their clothing to suit variations in season and weather, from some of which we may derive useful instruction. The change of coat in horses takes place in spring and autumn, and depends much on the character of the season; the thick winter

coat being slow to come off in a cold spring, but soon changing in continued warm weather; so likewise cold weather in the autumn accelerates the thickening of this coat, which in horses left to nature we find abundantly provided *before* the severity of the weather is established. Sheep change their wool only once in the year; but its rapid increase before the winter sets in, and its tardiness in loosening and falling off until June, when all the cold winds of the spring have passed by, afford useful suggestions as to the propriety of anticipating the cold by the protection of dress, and of patiently awaiting its subsidence before we remove that protection. Birds moult their feathers early in the autumn; at which period the new plumage thickens in down and feathery expansion as the winter sets in. In the spring, many of the downy feathers drop off, and are by many tribes appropriated to the lining of their nests; and through the summer the feathers continue to get thinner until the moulting season, when all give place to the new plumage.

But attentive observation of the phenomena and habits of animals displays to us farther means by which the same coat or plumage varies in its protective power with changes of the weather as well as of season.

Thus cold causes a partial erection (§ 120) of hairs and feathers, which has the effect of increasing the thickness of the covering which they form, and this retaining in its interstices a layer of warm air, increases its non-conducting and protective power. On the other hand warmth occasions hairs and plumage to lie close and smooth, so that they form a covering which is thinner, and more readily permits the escape of heat. Horses which are exposed in the winter often roll in dirt and mud, which concreting in their winter coat gives to it a thickness and power to resist heat, which it would be unwise to remove by the process of grooming. Hence curried horses require artificial clothing. The feathered tribes are generally protected from wet by their imbricated plumage, which is rendered more effective by the drooping direction which they give to their tails and feathers when exposed to rain. But they are supplied with another means of rendering their covering water-proof, in the oil with which their feathers are imbued. In aquatic birds this is so abundantly afforded from the skin itself, that their plumage scarcely ever becomes wet. In other birds there is less fat in the integuments; but the defect is supplied by the instinctive habit of pluming and oiling their feathers, with frequent inunctions, derived from the large oil gland over the tail. It is curious to observe how domestic poultry spend the greater part of a wet day in this occupation, which is no doubt luxurious as well as useful. Another habit which may be contrasted with the preceding, is noticed in warm dry weather; that of throwing dust or ashes into the plumage; perhaps the object is to remove any superfluity of oil, or it may be only to relieve themselves from the irritation of vermin with which they are always infested. Some land birds, more rationally, delight in washing under the same circumstances.

The preceding facts are not devoid of instruction in regard to the dress of human beings, who should learn to cover their nakedness under the guidance of experience and reason, which may be better or

worse than instinct, according to whether they are well or ill exercised. It argues little for the boasted superiority of man's reason, if it do not guide him to means more effectual in resisting the hurtful action of external temperature than those instinctively possessed by the lower animals; and yet there can be little doubt that none of these suffer from cold, wet, and atmospheric changes, to the degree in which human beings do. In truth, reason and common sense are too frequently set aside by foolish habits originating in vanity, fashion, caprice, prejudice, indolence, ignorance, or some such evil influence, and disease and infirmity are the penalties incurred by folly.

It will be the most convenient and concise mode of practically improving the subject of clothing, by considering the modes in which the physical influences which injuriously affect the body may be best intercepted by articles of dress.

646. We guard against external *cold*, by covering the body with such materials as, by their low conducting power and thickness, prevent the undue escape of animal heat. The most effectual for this purpose are furs and woollen fabrics; next rank thick spongy silk and cotton stuffs; and the lowest in power are linen cloth, and silk and cotton webs, so thin as to lose their protective property. The porosity of furs and woollen garments is valuable in permitting the escape of insensible perspiration, and on account of its lightness; but it impairs their protective quality against strong *currents of cold air*, especially if this be either very *dry* or very *damp*. Cold air in strong motion penetrates woollen stuffs of considerable thickness, and carries with it a dry or damp chill according to its hygrometric condition. In this power of penetration it is probably aided by the law of diffusion of gases (which applies to different amounts of watery vapor in air (§ 72). This consideration will account for the peculiarly chilling operation of a desiccating east wind and a cold fog; and the interference of both with the cutaneous perspiration as well as circulation, explains much of their injurious influence. The best protection against these agents, is to be found in leather or even more impervious textures, such as India-rubber cloth or oil-cloth; but these should not be worn too near the skin, lest they should prevent the proper escape of its perspiration, and cause an unhealthy dampness of the surface. Chamois leather may be used as a waistcoat over one made of flannel; and the still less pervious textures may be employed either in detached pieces, as in the piline and India-rubber chest protectors, or loin-belts, or in way of an outer garment as in Mackintosh capes, cloaks, and overalls, and these should be provided with ventilating apertures under the arms and elsewhere, to permit the free escape of the cutaneous exhalations. In this way we somewhat imitate the covering of birds, which in their flight are very much exposed to cold winds, damp or dry; their plumage being porous and downy underneath, but denser and impervious externally, whilst by the overlapping of their feathers a free escape is left for the exhalation from the skin. A similar advantage is obtained in an inferior degree by using several garments of different degrees of permeability, the warmest and most porous being worn next the skin, and others externally; this alternation of successive layers of different

properties increases the non-conducting power of clothing, and reduces the penetrative influence of cold and damp. There are very few instances in which flannel or fleecy hosiery may not form the best under dress during at least eight months in the year in this country, and a thinner material of the same kind, or merino (a mixture of wool and cotton), during the remaining four. The exceptions are persons of very irritable or relaxed skin, for whom an elastic cotton or spun silk material may be more suited. Warm under-dresses should not be worn in bed, as they then are apt to relax the skin too much, and render it more susceptible to the impressions of cold during the exposure of the day. Calico is the best material for the night dress; any required additional warmth being afforded by the bedclothes. It is of great importance to maintain the warmth of the extremities; there are few who can safely dispense with warm worsted stockings in the winter months; and those liable to coldness of the feet should also wear flannel or merino drawers and flannel linings to their shoes and boots.

647. Some of the kinds of clothing best suited to protect the body from *wet* and *damp*, have already been mentioned in the water-proof materials which also prevent the penetration of cold winds. For the exclusion of wet they should be worn outside of all other clothes, for the sake not only of permitting a freer escape of perspiration, but also of preventing the penetration of moisture into any part of the dress, for although the wet may not reach the body, its proximity may chill by evaporation. For the same reason the cardinal rule of keeping the feet dry is better accomplished by outer coloshes, gutta-percha soles, and varnish, or other means which exclude the wet on the outer surface of the shoes, than by inside cork soles or oil-silk socks, which allow the leather to be soaked in wet, and only intercepts its contact with the foot.

648. The change from winter to summer clothing should be made gradually and with great caution; and it is better to be tardy than hasty in change. The fitting period will vary in different seasons, but it rarely occurs before the month of May, often not until June; for although there may be warm weather earlier, it is generally of brief duration, and is alternated with bleak winds, which render the spring months peculiarly trying, and often cause more illness than all the continued severity of the winter. Much of this is to be attributed to the too early change of dress (§ 645). The converse rule may be applied to the change at the end of the summer; which is most prudently made in anticipation of the permanent cold. Many of the autumnal diseases arise from the great variations of temperature between day and night, and from sudden changes of wind, and these take more effect by finding the body relaxed by previous heat (§§ 25, 81), and yet protected by only summer clothing.

649. In this country even in summer the clothing is required to maintain sufficient warmth, more than to exclude heat; but it is now reduced to the thinnest and lightest materials, a slight woollen or cotton fabric being commonly retained next the skin to prevent the chilling dampness of the linen when wet with perspiration. Frequent changes of linen, where practicable, might supersede this precaution, and with free

ablutions are wholesome and refreshing during intense heat. Protection against solar heat and hot air is best afforded by loose linen vestments of light color, large straw hats, bonnets, veils, &c., which it is unnecessary to particularize.

650. It is very probable, that atmospheric electricity may exert an influence on the health, which may be, in some degree, counteracted by modifications of the dress. Thus silk vestments have a considerable protective influence by their property of non-conduction; and if worn next the skin, by friction they excite electricity, which is supposed by some practitioners to operate as a hygienic agent, in persons disposed to rheumatic and nervous diseases. Farther observations, carefully conducted, are needed to determine these points.

651. Under particular circumstances or conditions of the system, additional warm clothing is necessary; such as—in infancy, when the calorific power is low; in old age; in convalescence from acute diseases; during fatigue and other states of weakness; and in organic diseases of the heart, when the circulation is feeble; in case of privation of food; during the operation of purgative or diaphoretic medicines; and when circumstances prevent the use of a proper amount of exercise. Under the influence of these conditions, the feeling of chilliness, particularly on the surface and in the extremities, is an indication of the need of more clothing, and if this be used to prevent the sensations of cold it will often counteract those disturbances of the circulation and internal congestions to which the weakened body is liable (§§ 79, 292), and which lay the foundation of many diseases.

No part of the frame requires the protection of clothing so little as the head and face. The final cause of this comparative freedom from the bondage of garments, is obvious in a part where free communication with the exterior is necessary for the senses, breath, speech, and nourishment. The physiological cause of the greater power of the head in resisting cold, may be probably found in the larger size and less varying caliber of its bloodvessels (§ 266), which, even in weakened states of the circulation, secure an amount of blood which may cause a sense of heat and fulness, when other parts are suffering from the opposite feeling (§§ 330, 331). But even for the head, during exposure to the air and during the night, it is expedient to use such light covering as may prevent checking the perspiration of the surface, and more particularly the ceruminous secretion in the ears, the proper continuance of which is essential for the preservation of hearing. I do not, therefore, approve of a favorite modern practice of altogether discarding nightcaps, and I have known it to induce catarrhal affections of the eyes and nose, earache, and deafness. Those who thus suffer, or from dryness of the scalp, may find much benefit from wearing at night an oil-silk cap over a thin nightcap.

Various other cautions and directions with regard to clothing are sufficiently dictated by principles of common sense to supersede the need of our dwelling on them—such as the frequent changing of garments, especially under ones, for cleanliness sake; the avoidance of all tight ligatures, lacings, or buttonings, which may cause improper pressure on any part of the body, and interfere with free motion, circula-

tion, perspiration, &c. The invention of India-rubber web and other elastic materials, has supplied a valuable means (not used so generally as it deserves) of avoiding these evils, and of yet maintaining a due apposition and attachment of various articles of dress.

AIR AND TEMPERATURE.

652. The subject of impure air as a cause of disease, has already occupied our attention (§§ 72, 73). We now have to notice the states of the air most conducive to health; and inasmuch as temperature is chiefly conveyed through the air surrounding the body, it will be convenient to include a few remarks on this topic under the same head.

The invigorating influence of pure, fresh air may be partly referred to its superior purity more perfectly adapting it to the purpose of respiration, but somewhat of its refreshing effect is due to its direct operation on the nerves and capillaries of the surface of the body, and through them on the functions generally. This is exemplified in the reviving effect of a current of fresh air, or of fanning, on persons in a state of faintness, and this effect is more remarkable when the air is cool and the body has been previously weakened by heat and confinement; but the continued action of a cold current would be hazardous under these circumstances. The less marked but more enduring benefits of fresh air, are experienced in rides, drives, or other exercises, passive or active, which are universally acknowledged to be essential means of maintaining the bodily health. To obtain the greatest amount of good from these airings, it is useful not only to resort to localities where the air is most pure and free from contamination, but also to vary its qualities in other respects. Thus the inhabitants of valleys derive benefit from the air of hills; those of inland places from that of the sea; and residents on the sea-coast derive advantage from drives inland. For a similar reason, much improvement of health often results from continued travelling by land or sea, and although this comprises other hygienic elements besides change of air, experienced travellers rarely fail to distinguish this as one of sensible efficacy, exercising a marked effect on the several functions. Similar beneficial results sometimes ensue from moderate and favorable changes of weather, which bring an altered state of atmosphere even to our own homes. It is by no means certain on what physical properties depend the all-varying hygienic influences of air in changing weather and different localities; but it may be useful to notice somewhat of the operation on the body of air in different states of *dryness* and *moisture*, *temperature* and *purity*.

653. A very *dry* air exerts on the body the physical influence of rapid evaporation and a high degree of electric tension; the resulting operation on the functions is generally more or less stimulating. The tonicity of the textures is usually augmented, whilst the desiccating, and probably also the electric action of the air on the cutaneous and mucous surfaces, induces an excitement which is beneficial in those of relaxed and leucophlegmatic habit; but in the irritable and sanguine,

may lead to inflammation or fever. A very dry air, the effect of which is increased by its heat or motion, impairs the perspiring power of the skin, and excites various kinds of cutaneous inflammation, often with fever and thirst. In moderate degrees, and at mild temperatures, dryness of the air is salutary, by facilitating the purification of the blood in the lungs (§ 72), by improving the tone of the moving fibre, by checking tendencies to excessive secretion, and by counteracting various septic processes, both within and without the body, which are generally promoted by humidity. We formerly had occasion to notice that dryness of the air is one of the best safeguards against the activity of miasmatic poisons (§ 83). Another reason for commonly preferring a dry air as the most healthy, is because we can more efficiently counteract the injurious operation of dryness than that of moisture. A judicious use of bathing, warm or cold, exercise and friction, which by inducing gentle sensible perspiration remove the dryness of the skin; the prevention of too rapid an evaporation from the surface by means of inunction, emollient applications, and difficultly pervious coverings, such as oil silk, leather, &c., on parts which suffer, will generally succeed in preventing the hurtful influences of dryness in the air without interfering with its salutary effects.

Dryness of the air is most permanently obtained in connection with a dry soil, from which the water of rain and dew speedily drains off, or evaporates, as on rocky surfaces; or sinks deeply, as in sand, chalk, and light gravel. The nature of the subsoil is therefore of the greatest importance in determining the character of the air of a locality; and the kinds above mentioned are the most favorable to permanent dryness of the air. A declivity or undulating surface and a freedom from dense foliage and very luxuriant vegetation, contribute also to the dryness of a neighborhood, and generally thereby to its salubrity. Dryness in the air is also remarkably connected with the prevalence of certain winds in this hemisphere, especially those from the east, the aridity of which is due not only to the much rarer occurrence of rain which they bring with them, but also to their smaller proportion of dissolved moisture. And because such winds prevail more in strength and frequency on the eastern than on the western portions of these countries, the former have for the most part a drier air than the latter. But in addition to dryness, easterly winds have other qualities which detract much from their salutary influence on the animal frame, and often prove positively injurious. Thus the north-east and due east winds are remarkable for their bleakness and penetrative coldness (§ 646); and except in persons whose circulation is naturally strong and kept in activity by exercise, their tendency is to check the passage of the blood in the surface and in mucous membranes, and impair the functions connected therewith. Farther, the objection to exposed situations on account of the capricious and changeable character of the winds which act on them, applies with peculiar force to those with an eastern aspect, on which the transition is more than usually sudden and extreme, from the power and bleakness of the returning cold.

The south-east wind is also dry, and in winter and spring differs from those more from the north in its milder temperature; but as sum-

mer advances, it is remarkable for its sultry and oppressive quality, which in south Europe is exemplified in its acme in the operation of the *sirocco*. Much of the overpowering influence of this air may be explained by its desiccating operation (manifest not only in animals by the thirst and feverish dryness of the skin and mouth, but also in plants and trees by the drooping of their leaves), combined with the relaxing agency of heat on the vascular fibre, by which the powers of the circulation are enfeebled, and the purifying processes of respiration and secretion are more or less impaired. But doubtless something of the peculiar effects of a south-east wind is due to electric tension; and in this country their extreme manifestation generally precedes the occurrence of a thunderstorm; nor should be forgotten the fact formerly mentioned (§ 92, *note*), that during the prevalence of this wind especially the air becomes surcharged with animalcule tribes, and certain epidemic diseases, especially Asiatic cholera and sometimes influenza, make their greatest progress.

654. A damp or moist air, irrespectively of its temperature, may be considered as lower than dry air in its vivifying power, inasmuch as it contains less free oxygen, and has a lower diffusive property to aid in its pervading the lungs in respiration. The greater facility which it affords to processes of decomposition and infection should also be scored against its salubrity, as well as other points in which it may be contrasted with moderately dry air. A warm moist air is universally relaxing (§§ 25, 123), and unless in persons of dry skin and over-braced vessels, is oppressive and debilitating. Under its influence, perspiration accumulates on the surface, perpetuating its relaxation if warmth continues, and chilling it and impairing its circulation and excretion if cold ensues; and the very evaporation from the moistened surface, which even in mild damp air may occur from draughts or currents, may under such circumstances cause an injurious chill. More surely pernicious in this manner is cold damp air, which is proverbially unhealthy, and its disordering action may be in great measure traced to the physical properties of abstracting heat and electricity, and of checking perspiration and assimilation, which it obviously possesses. Hence ensue the retention of lactic acid in the blood, the formation of oxalic instead of lithic acid, and the imperfect elaboration of the plasma; and these aberrations from the normal chemistry of the body, may manifest themselves in the shape of various diseases of the blood and circulation, of which rheumatism, neuralgia, sundry cutaneous affections, cachectic ulcers, tubercles, scrofula, &c., are familiar examples.

The most efficient cause of dampness in the air is the permanent retention of moisture on or near the surface of the ground, as in low grounds in which clay prevails, and where water accumulates or is imperfectly drained off, and where evaporation is retarded by the shade of many trees, or of high rocks or hills. But independently of soil, a house may be damp from its own materials, which from recent construction, or from their tendency to attract and precipitate humidity (as in case of those built of limestone or marble), are constantly impregnating the contained air with humidity. Wet weather and damp winds, such as the south-west, are less injurious causes of humidity,

because less permanent; but their influence is often manifest during their continuance, and always most so in localities that are damp from other causes. The air of the seaside, even on the south-west coast, although generally abounding in humidity, is far less injurious than that of damp places inland; apparently because much of the sedative and chilling operation of marine humidity is counteracted by the stimulating influence of the saline particles which it contains. The different effect of a sea fog and a land mist is well known.

The hygienic directions with regard to moist air are chiefly of a protective or counteracting character. Artificial heat is the most available and efficacious desiccating agent which we can command; and, if combined with adequate ventilation, it may do much to remove dampness of air within doors, whether arising from the soil or from the building. In warm weather, when fires are unpleasant, much unhealthy moisture may be removed from the air, by so adjusting doors and windows, or air-holes, that ventilation may be secured without opening those facing the dampest vicinity. In limestone districts, much good results from keeping large pans of quicklime in several apartments, especially those of the basement and ground-floor. This expedient, for reasons before mentioned, is a serviceable precaution against malarious and infectious diseases; its utility has long been known in preventing meat from becoming soon tainted in a damp larder.

To diminish the dampness of clay and marshy soils in the immediate vicinity of dwellings, much may often be done by an efficient system of covered drainage; by the removal of superfluous trees and shrubs; and, where practicable, by covering the surfaces which are most constantly wet, with light sand, gravel, brick and mortar rubbish, or some similar light and porous material, which may form an artificial superstratum and intercept the influence of the damp ground. The insalubrity of many low parts of the metropolis, especially in Pimlico and Westminster, has been wonderfully diminished by the latter expedients. A parallel protection against the damp of limestone walls of houses is obtained by the process of battening or covering the wall with wood and canvas, or lath and plaster. The free use of concrete, or of slate or metallic plates in the foundations of houses, to prevent the rising in the walls of moisture by capillary attraction, should never be neglected, particularly in damp localities, where the lower parts of the building are likely to be inhabited.

655. The subject of *temperature* of the air has been frequently introduced in the preceding remarks, and it will be superfluous to dwell long on it here. The average temperature most generally conducive to comfort and health, is about thirty-five degrees (of Fahrenheit) below the heat of the interior body; that is, 63°; blood-heat being 98°. In sustaining an artificial temperature in the air, it is rarely expedient to exceed this; for the purity and invigorating properties suffer at higher temperatures, and if more warmth is needed than what results from air at this point, it should be supplied by clothing or other means. The advantage of keeping the atmosphere of apartments considerably cooler than the body itself, consists, not only in the greater amount of oxygen contained in a given bulk, but also in the greater force with

which the foul air of respiration is carried away from the breathing passages, and a pure air supplied, in consequence of the difference of temperature maintaining a current. The converse of this is a chief reason why over-heated rooms are peculiarly oppressive, unless the air be changed by efficient ventilation, and why warming rooms by stoves, or heated air, causes a feeling of closeness which does not result from open fireplaces, which communicate heat chiefly by radiation, and leave the air comparatively cool. The animal body being naturally much warmer than the surrounding air, operates as a ventilator for itself, by the same consummate adaptation of pneumatic laws as that which supplies a flame or fire with a continued current of fresh air; and as we see a fire burn brighter and clearer in frosty weather, so an animal breathes a purer, denser air, which, if not injurious by its cold, is refreshing and invigorating to the body. Not only healthy and robust persons, but also some who are asthmatic, or otherwise weak in respiratory power, acquire increased strength and energy in clear cold weather; and even those who, from weakness of circulation, cannot resist continued cold, and usually require a mild atmosphere, are generally refreshed and benefited by breathing cold air for short periods, when exercise and warm clothing protect them against its sedative and chilling effects.

656. The use of artificial heat is greatest in young infants and very aged persons; in whom the intrinsic calorific power is too low to bear safely even the temporary exposure to wintry air just mentioned as useful to some weakly subjects. So, too, those who suffer in the lungs and air-passages from even brief impressions of cold, which is the case with the greater number of pulmonary invalids, should not venture into the open air during cold weather, without the protection of a respirator, which acts as a kind of clothing to the air-passages; and although it detracts from the refreshing coolness of the open air, it does not materially impair its purity. I have known this instrument prove useful also in the case of anæmic subjects, and others of low calorific power, not merely by protecting the air-passages, but also by retaining the heat which is generally expended in the expired air.[1]

657. The necessity of maintaining the purity of the air by its continued change has repeatedly been noticed in the present and preceding chapters (§ 72). In cold weather, this change is greatly promoted by the difference of temperature in the air heated by respiration or by the fire of a room, and that of the surrounding atmosphere, and the increased ventilation thus insured has been mentioned as a cause of the more invigorating properties of the air in winter. In hot weather, on

[1] Various expedients for retaining the warmth of the breast for the purposes of animal temperature, were long since recommended by Dr. Arnott and others. An incident in point, which occurred to myself many years since, may afford a useful hint to others in a similar predicament. I had to go a long journey on a cold winter's night; and there being no room inside the mail, I was obliged to ride on the outside, although insufficiently clothed for the exposure. Reflecting on the great loss of heat manifest in the steaming breath of myself and fellow-passengers, I endeavored to retain a portion of it by entirely covering the head and face with a silk pocket-handkerchief, the lower ends of which were closely tucked inside the buttoned coat. The result was a retention of warmth, not in the face and chest only, but even in the extremities, more comfortable and diffused than an additional greatcoat could have produced.

the other hand, and in apartments heated through the air more than by radiation, it is necessary to provide means to assist the motion of the air. In summer, this may usually be effected by open windows and doors; and the close smell which shut-up rooms acquire in summer, generally suggests this remedy. In India, and other hot climates, where even the outer air is so hot and still that it supplies no movement, machines are used for creating a current of air, and of farther cooling it by evaporation from a moist surface. Even sprinkling floors and walls with water is useful, not only in cooling the air, but also in thereby promoting its motion.

In cold weather, some degree of ventilation is commonly insured by the fires employed for the purpose of warmth; but it is often in an irregular or insufficient manner; as by draughts of air under doors, and through the chinks of floors, which cause a cold current on the feet and lower parts of the body, whilst the head and breathing passages, which are above the level of the fireplaces, are above the current, in a stratum of warm and less pure air. It is quite true that by the law of diffusion of gases, as well as by the force of the currents, and other means of agitating the air, a change is effected in the whole air of a room; but it is so, less completely and rapidly than is desirable for so important a purpose as the constant supply of pure air for respiration. To obviate these defects, various ventilating contrivances have been recommended, and none for simplicity and efficacy excel those recommended by Dr. Arnott, which not only form apertures calculated to promote a continued change of air in the room, but, by means of a simple self-adjusting valve, they may be made to prevent too strong a current or one in a wrong direction. For perfect ventilation, two apertures (or sets of them) are requisite; one for the supply of fresh air, another for the exit of that which is foul. These should be placed at opposite sides of the room, and it is generally advised that the outlet should be placed near the ceiling, which is certainly the best position; and it may be made into the chimney where a fire is used (an efficient valve preventing the influx of smoke), or through the ceiling or roof, or in a top window-pane, where there is no chimney. For the purpose of affording the freest influx of air, an aperture near or in the floor would be the most suitable position; but it is objectionable on account of the chill which it communicates to the feet and lower parts of the body. Commonly, therefore, the inlet for fresh air may be made in the upper pane of a window or panel of a door, most remote from the outletting aperture; and to prevent draughts, and to promote the diffusion of the air through the room, the opening should be covered with wire-gauze, or finely perforated zinc plate, in addition to which, if necessary, an oblique screen of wood or curtain may be placed before it to direct the current to the walls and ceiling. By these means, the fresh air, which is heavier, because cooler than the air of the room, gradually falls, and is dispersed, displacing the warmer foul air; and reaches the middle of the room cool and refreshing for the heads and breaths of the inmates, yet causing no draughts on the lower extremities. In very cold weather, it is certainly advantageous to have the supply of external air moderately warmed before it enters the room;

and the best method of effecting this, is by means of a well-regulated warm-air stove, or an Arnott stove, with a current of fresh air directed on it, placed in the hall or at the bottom of the staircase. This inlet of a gently warmed air, is useful, not only by taking the excessive chill from the outer air, but also by affording such an influx into the house as supersedes those irregular draughts, which, for want of other supply, force their way through every chink, hole, and cranny in the floors or walls, and which, besides a chill, often bring with them dust and bad effluvia acquired in their passage from without (§§ 72, 73). The extreme dryness of the air thus warmed may be removed by shallow earthen pans containing water, placed on the stove.

658. The ventilating force operating in all the cases hitherto noticed, is that depending on atmospheric pressure, displacing air rendered lighter by heat, animal or artificial; and this force, properly applied and directed, will suffice for the ventilation of ordinary dwellings. But for large public buildings in which great numbers are congregated, or where other causes of contamination or impurity operate, as in manufactories, hospitals, mines, holds of large ships, &c., this force may be ineffectual; and even when aided by extra fires and lengths of chimney, it is not sufficiently under command or regulation to be properly adequate for the purpose. The other forces which have been applied to effect ventilation on a large scale, are mechanical powers, and the operation of a jet of high-pressure steam. The latter is very efficient in creating a strong current of air which is chiefly applicable to the drawing off of foul air. It is proposed to be applied by Mr. Barry, as a chief force in the ventilation of the new Houses of Parliament; but time will show how far it will prove adequate. The noise caused by it would be an objection in some cases. Mechanical ventilation has long been practised through the revolving fan-wheel; but Dr. Arnott has shown that its propelling power is very limited; for where resisted by any opposing current equal to the pressure of a column of seven inches of water, it no longer creates a current, but revolves with increased rapidity, carrying the air with it instead of through it. This scientific physician has devised a mechanical ventilating apparatus, which in amount and steadiness of power, and the perfect facility with which the air supplied can be regulated, excels every contrivance hitherto accomplished or proposed. Such a machine, which is a kind of pump, moved by steam, and which propels air in a precisely measured quantity and regulated temperature, has been constructed under Dr. Arnott's directions at the Hospital for Consumption at Brompton; and so far as can be judged from a trial of four or five months, appears to be perfectly successful in its operation. This machine introduces into the building about two thousand cubic feet of air per minute, which passing over six hundred square feet of surface heated by steam, supplies an abundant amount of fresh air, moderately warmed. The foul air escapes through valvular apertures into the chimneys of each room.

659. Besides the supply of fresh air to the interior of buildings, means to preserve from contaminating effluvia are frequently required, especially in large towns. Systematic and scrupulous cleanliness, and an adequate and air-tight drainage are most effectual for this purpose.

Some recommendations on these subjects have been already given under the head of exciting causes of disease (§§ 70, 73). For the purpose of cleansing, an abundant supply of water is essential to the wholesomeness of a habitation; the evils of impure air are commonly experienced where this purifying element is scanty. Additional means of purification are afforded by certain chemical agents which absorb or decompose noxious effluvia. Lime is a cheap and useful material for this purpose, and may often be advantageously used both by lime-washing walls and ceilings, and by pans of quicklime kept in the basement story of houses near any source of foul air. Other disinfecting agents are still more powerful, and at the head of them undoubtedly stands chlorine, which is invaluable in destroying noxious effluvia, the source of which cannot be stopped. Chloride of lime and dissolved chlorinated soda, are convenient materials to afford a moderate supply of the gas, which, if required, may be extricated in greater quantity by the addition of an acid. But a cheaper and more abundant source is supplied by black oxide of manganese, common salt, and sulphuric acid; the acid being added from time to time in small quantities throughout the day.[1] Under circumstances in which the operation of chlorine is too irritating, nitric or acetic vapor may be substituted, but they are less effectual and must be used in greater abundance. In houses in which unmanageable drains or immovable cesspools taint the air, some of these disinfecting agents should be kept in perpetual operation.[2]

BODILY EXERCISE.

660. The want of exercise has been noticed as predisposing to, and exciting disease (§§ 24, 65); and the opposite extreme, excessive exertion, was mentioned as equally detrimental in its effect on functions and structures (§ 64). The place which exercise occupies as a hygienic agent is therefore between these extremes; and its utility and importance will be proportioned to the regularity and discretion with which it is practised.

Moderate and sustained exercise in healthy air, as in walking, riding on horseback, and in various occupations and pastimes, excites into activity most of the functions of the body, especially the circulation, and respiration, or those intimately connected with these, the secretions and animal heat; and provided the fatigue or exhaustion resulting from this excitement be adequately removed by sufficient rest and sustenance, the functions gradually gain vigor by their activity, and the structures exercising them acquire a fuller and healthier development. The muscles especially, including the heart, manifest an

[1] A cheap and convenient apparatus for fumigating with these materials has been contrived by Mr. Smith, of White Street, Borough, and to be obtained of Hoare & Co., 123 Newgate Street.

[2] The subject of public sewerage and others connected with these topics, is too extensive to be entered on here; and the reader will find much valuable information in the Report lately published by the Sanitary Commissioners, from whose continued labors much good may be expected.

increase of strength and firmness; the bloodvessels are improved in tone, by which they distribute and equalize the flow of blood through them, and prevent partial congestions and obstructions; and the blood, actively carried through the organs and textures, undergoes the complete series of changes from nutrition, purification, arterialization, by which its integrity is maintained, and it is adapted in its turn to sustain the several functions of the body. The appetite, the digestive powers, the intestinal action, the warmth of the surface and extremities, the spirits, and temper, are generally all improved by the habit of regular exercise; and what can we say more to recommend any hygienic agent? But as much of its beneficial effect depends on the judicious manner in which exercise is adapted, in kind, time, and degree, to the strength, habits, occupation, age, sex, and other circumstances of the individual, it may not be superfluous to indicate a few cautions and directions on the most important of these points.

661. In childhood, youth, and early maturity, when the joints are supple, the textures in full elasticity, and the whole frame adapted to the quickest and most varied movements, diversity and activity in muscular action are suitable and salutary; and there is pleasure as well as benefit in exceeding common modes of exercise by varied feats of agility and strength, which call into play all the muscles of the body, as in running, leaping, climbing, wrestling, rowing, and various athletic games, such as crickets, fives, tennis, quoits, &c. But at this youthful age there is less power of endurance of continued fatigue than in maturer life, and the body more absolutely requires repose after exertion. The health of young persons, especially of the female sex, is often much injured by too long walks, especially if frequently repeated, whilst they may comparatively suffer little from greater exertion for a shorter period, as in dancing, or riding on horseback. In adult age, on the other hand, prolonged exertion is better borne than exertions requiring great agility of movement; and unless a youthful mobility be preserved by continued practice, more sober and steady motions are more fitting to the sedate age. Exercise on foot and on horseback on the ordinary mode, except among the working classes, whose occupations engage them in various kinds and degrees of muscular exertion; and in all these species of exercise and work, experience teaches, long before the period of middle age, that more is safely and comfortably to be done by steady and sustained exertions, than by sudden or rapid efforts. But it does not therefore follow, that the exercise taken for the sake of health in middle age should be monotonous or slow. Persons much engaged in employments either sedentary or confining them within doors with little exertion, would feel little benefit or refreshment from the hour or two which they can spare for out-of-door exercise if it were passed in mere sauntering or strolling on an unvaried road. A brisk walk, diversified as much as may be in direction, including, if possible, ascents and descents, and away from the vicinity of the smoke and effluvia in which the rest of the day is spent, and alternated with an inspiriting ride on a free-paced horse, or with the healthy exercise of active gardening, or the like pursuit, will most profitably fill up the time which the middle-aged man of business can devote to exercise,

and he will then soon find it a very safe and remunerating investment. On the other hand, he who, forgetting what becomes his age, relishes no exercise but those associated with the excitements of the ball-room, the cricket-ground, the rowing-match, or the hunting field, speculates with a capital of mobility and elasticity which he may not possess, and although he may sometimes boast of a successful result in recovering activity and health lost through previous habits, yet he encounters a perpetual risk of breaking down under the unusual strain to which he subjects his frame, and he gains none of that gradually renovating and invigorating influence which is produced by more moderate exercise regularly practised, although varied from day to day. In old age, the sphere of exertion is still farther limited by functional and structural changes before noticed (§§ 48, 546), and exercise, although still salutary, must be still farther restricted in degree and variety. Quiet walking or riding on horseback may be practised by many, even far advanced in years; and carriage exercise (such as it is, which is scarcely any) remains for the more infirm. The selection of these, and the extent to which they are beneficial, will depend much on the previous habits as well as on the present condition of the individual. If a man has lived a sedentary life, and has become stiff and prematurely old in consequence, this is not the time to commence habits of activity, which would endanger the integrity of his vegetating or mineralized structures (§§ 543–6). A similar caution is applicable to those who have lived *too fast*, and by various excesses and undue excitement and strains, have exhausted their vital powers and accelerated the degenerative changes in their textures; such persons manifest by their feeble and tottering gait and breathlessness on exertion, an inaptitude for exercise, which should caution them against its being attempted. Carriage airings and gentle frictions of the surface and extremities are here the best substitutes. It is different with those, who, by a temperate and judicious mode of living, with habits of activity proportioned to the strength and age, have economized their vigor, and given fair play to their constitutional powers; these may be said to enjoy a green old age, in which a capacity for moderate exercise continues to be not less a source of recreation and comfort than a means of sustaining health; but even these fine and in all respects venerable specimens of ameliorated humanity sometimes need professional warnings against presuming too much on their well-husbanded strength. They are often carried off by acute attacks, which have been brought on by their stepping out of their sphere of safety, which although wider than usual at their age, has nevertheless limits, which the steady hand of time is daily narrowing, but in so gradual and imperceptible a manner, as to escape the attention of their own mental powers, now also on the wane. Hence one act of imprudence may be followed by fatal results; and that may be deemed to be imprudent which in any material degree exceeds the bounds of the accustomed habits.

662. The times at which exercise is most salutary, in relation to meals, occupation, and repose, are commonly those in which the bodily powers are not too low from fasting, fatigue, or wakefulness, nor oppressed by the process of digestion. Exercise before breakfast is suita-

ble only to the robust, and those who have fed late and largely on the preceding day; delicate persons commonly become faint from exercise at this time; and others that do not immediately suffer, lose a degree of the appetency and digestive power which render the meal agreeable as well as useful, and thus consequently are more languid during the early part of the day. Shortly after breakfast is commonly an eligible time for exercise; this meal is sufficient to remove the squeamishness or faintness apt to arise from an empty stomach, yet it is not, or should not be, so heavy as to oppress the bodily powers, or prevent their capacity for moderate muscular exertion. Those who can command the time, will find it advantageous to intersperse their sedentary occupations with short periods of exercise, if possible, in the open air; if this be only for ten or fifteen minutes, once or twice in the course of the forenoon and afternoon, it will contribute to counteract the bad effects of confinement, and by giving a fresh impulse to the circulation and respiration, it will remove congestions, cool the head, warm the feet, and thus tend to refresh both body and mind. For similar reasons, it is well that more extended exercise should be taken twice rather than once daily, the second period being after the early tea, or before late dinner, as arranged under the head of *Food* (§§ 643–4). Those whose occupations are fatiguing either to body or mind, and who are obliged to dine late, may not have strength sufficient to bear the second period of exercise before dinner; but they may be enabled by an hour or two of rest after this meal to take an evening walk, which will be found well-timed and refreshing, especially in the summer. Under all circumstances it is of importance to avoid much fatigue both before and soon after dinner. This being generally the principal repast, needs more than other meals, the undisturbed energies of the system for its digestion; and if either the body is exhausted by exertion beforehand, or its energies are diverted from the digestive organs by exercise taken soon after the meal, the digestion will be disturbed, and various evil consequences may ensue. It is the chief objection to very late dinners, that after the toils of the whole day, the body is too much exhausted for the work of digestion, and stimulants are always needed to aid in the process, which they do but irregularly and imperfectly.

663. The weaker or more delicate is the individual, the more necessary are the above-mentioned cautions against excessive or ill-timed exercise. The time to be devoted to bodily recreation will vary much with natural strength and habits, and the kind of exercise used. Females and delicate persons will rarely benefit by more than from half an hour to three quarters of an hour's walk, or nearly double those periods of gentle horse exercise; but robust males may find advantage in a considerably greater amount.

664. Exercise varies in effect according to its kind. Walking, although giving some action to most of the muscles of the body, chiefly exercises those of the lower extremities; and by increasing the circulation and perspiration, especially in that direction, it tends to derive from the head and chest, and to relieve congestions of these cavities. Riding on horseback gives more exertion to the loins, and by the regular movements which it communicates to the viscera of the abdomen,

pelvis, and thorax, it promotes their circulation and functions; it is not equally effectual in equalizing the circulation in the head and extremities, and in cold weather, especially, often causes headache, which may generally be prevented by taking measures to keep the feet warm.

Some kinds of exercise which include alternate stooping and raising the body, such as digging and other occupations in the garden, are serviceable in promoting the action of the bowels and kidneys; and the same remark will apply to various games of bowls. Rowing has the advantage of very generally and uniformly exercising the muscles of the whole body; but unless it be practised with moderation, the simultaneous pressure which it exerts on every part may prove injurious, by overstraining the organs of circulation and respiration (§ 64); and many proofs have come within my observation of the evil consequences of boat-racing.

MENTAL OCCUPATION.

665. Under this head may be comprised a short notice of the mental influences which most conduce to the maintenance of health. As with the corporeal functions, so with the mind, a moderate and equable activity, with some variety of excitement and relaxation, contributes to its well-being; and inasmuch as the body is greatly under the influence of the mind (§ 66), the health of both is, therefore, equally promoted. The kind and amount of mental exercise must vary considerably, according to different circumstances of age, sex, temperament, capacity, and habits of the subjects. The topic is far too wide to be comprehended in the very cursory glance which we can give to it, and it must suffice to notice some variations of mental discipline adapted to these different circumstances.

666. In infancy, the sentient and perceptive functions are active, the emotional feelings lively, whilst the higher, moral, and the intellectual faculties are very imperfect. Hence the sensitive excitability of this age, which becomes a frequent cause of disorder; and to moderate this by various soothing expedients, as by gentle and lulling impressions on the senses, with timely resorts to varied amusing toys, and other objects to divert attention, and gently exercise the organs of sense and perception, is the chief aim at this early period. But as infancy passes into childhood, there is sufficient development of moral feeling and understanding to supply farther means of control and direction; and although at this age it is equally necessary to avoid causes of fretfulness and passion, the principle of self-control and patience may now be properly inculcated by moral and religious instruction, enforced by a consistent example of kindness and justice in the conduct of those who manage the children. The mental, as well as the bodily powers, at this early age, have no endurance—they are soon fatigued; and nothing can be more hurtful than to excite them too much, or too long, by games or scenes of amusement; exhaustion, fretfulness, and bodily suffering are the common consequences of such excess, and disease not unfrequently follows. A similar objection may be urged against too early or too prolonged attempts to educate the mind; such

attempts anticipate the period at which the power of concentration, or sustained attention, is acquired, which it can be safely only by time and practice. Children precocious in intellect gain this power early, but this is a reason against its exercise, which would the more readily tend to strain the active faculties to a morbid degree.

667. As the mental capacity becomes enlarged by equal and judicious exercise in ripening youth, it is adapted to longer and severer tasks, and in addition to the advantages of thus improving the intellect by extended occupation at this age, the moral emotions and animal passions, which now acquire strength, are hereby moderated and kept in subjection. A leading rule to be observed in all attempts to develop and regulate the mind is, to exercise its powers as equally as possible; the natural tendency is, that those powers which are constitutionally strongest should overrule and weaken others, and this applies to the impulses of moral feeling as much as to intellectual capacity. A main purpose of education is to prevent the inequalities, by exercising the weaker powers, and judiciously restraining those which unduly predominate. Herein education includes not the mere communication of knowledge, but the discipline of the heart and mind; the subjugation of evil and useless inclinations and propensities, and the direction of the attention or activity of the intellect to objects that are profitable and improving. The influences by the aid of which this discipline may be exercised are manifold, and must, in some degree, vary with the age and with the character of the individual. In childhood, respect and love towards parents or others exercising authority; in youth, the same feelings confirmed and cultivated by the convictions of the understanding now giving increased spontaneity of thought to the individual; and in all ages, the constraining and elevating influence of religion in supplying the highest motives and rules for the conduct of thinking and responsible beings; these are the great leading instruments through which mental discipline is safely and effectually applied. But other and less dignified motives are often equally powerful, such as vanity, pride, ambition, rivalry, and the like; and although they prove the failing of the human mind from a standard of perfection, and, unless controlled, may become exaggerated into vice, yet under restraint they may be usefully enlisted on the side of mental improvement.

668. When youth ripens into adult age, although technically speaking education is complete, the discipline and culture of the mind (which are the objects of education) are still to be carried on with all the activity proportioned to the full development of the faculties and passions. This being the period at which the authority of parents or seniors is more or less relaxed, and the individual is of age to take full responsibility on himself, it is of the utmost consequence that his mature powers should be directed in a career which may promote his present and permanent welfare; and much, in regard to his future health, depends on the possessing such ascendency of mind over body, of moral over animal feelings, as may secure the establishment of wholesome habits of wisdom and temperance. The subjugation of gross appetites; the subordination of all turbulent or violent moral and mental emotions; the cultivation of the gentle and calming feelings

fostered in domestic life or in refined social intercourse; and the regular but moderate application of the intellectual powers to some definite object or set of objects worthy of their pursuit;—are items of mental discipline becoming the age of maturity, and if steadily practised cannot fail to conduce, not only to the health and endurance of both mind and body, but also to their lasting comfort and happiness. It is true that many difficulties beset the beginner in his endeavors to follow such rules; many struggles against the inferior part of himself; much exercise of patience and forbearance in regard to others; a frequent practice of self-control in avoiding the temptations of excitement and intoxicating amusement; and a constant vigilance over the mind, to restrain it equally from wandering into by-paths away from its proper road, and from lapsing into desultory abstraction or indolence; and these impeding forces within, are often prompted or seconded by not less formidable obstacles without, thrown up by the multitudinous and ever-rising temptations and trials of life—never absent, but often peculiarly besetting its anxious and unsteady commencement. Need we say, then, that the efforts should be proportioned to the difficulties? and, with the full and rational exercise of human means, but with humble and faithful dependence on more than human guidance and strength, these efforts will never prove unsuccessful.

669. But it is our more special object to indicate the modes in which reciprocally the mind and body may promote each other's health; and which may be summed up in the Platonic axiom that they should be well balanced in their exercise and activity. The undue or too prolonged occupation of the mind with deep study or thought abstracts the supply of blood and of vital energies from the bodily functions: these suffer and fall into weakness and disorder, whilst the nervous system, the material organ of the mind, is ultimately exhausted by the continued excitement, and refuses to perform one of its manifold functions; hence stupor, paralysis, or organic weakness of some kind may ensue; or others may retain a morbid erethism or irritation in the midst of general weakness; and delirium, spectral illusions, sleeplessness, tremors, spasmodic or painful affections may be the consequence. Mental idleness, on the other hand, not only weakens the intellect by disuse, but, by inducing habits of indolence and self indulgence, pampers the body and perverts its proper functions, degrading them to an approximation to brutal or even vegetable life. Moderate and well-timed exercise refreshes the mental powers, and enabling them to apply with renewed vigor, increases their permanency and sphere of action. So likewise, pleasing mental impressions, as from beautiful scenery, congenial associations, and interesting pursuits, heighten the benefits of bodily exercise, and give all the faculties that renascent energy which is well expressed by the term *recreation*. A similar advantage accrues from varying the kind of mental occupation; thus music, drawing, amusing games, and light reading, are to many, more effectual than absolute rest, in refreshing the mind after severe study or close application. In like manner, intellectual tasks of different kinds may be profitably alternated with each other, as the several muscles of the body are more beneficially exercised in succession than

all at once (§ 664). Analogous rules may be applied to the moral emotions, so far as they can be placed under the direction of the individual; and there is in most energetic minds somewhat of a natural or habitual succession of high and low spirits, of lights and shadows in the mental hemisphere, which, however trying and hazardous it may be in extremes, when occurring in moderation, gives a renewed vigor to thought which is wanting in minds of more perfect placidity.

SLEEP.

670. It would be quite superfluous to expatiate on the health-giving influence of a due amount of tranquil sleep. It is the chief means of recruiting the exhausted energies of the animal functions; and some of the causes and consequences of its failure have been already noticed among the causes and elements of disease (§§ 23, 56, 64, 154). It appears to consist in a more or less complete suspension of the cerebral or sensorial functions, with an increase of the medullary and organic nervous influence; and we have suggested that a modification in the distribution of the blood through the nervous centres may be instrumental in thus periodically reducing the activity of those parts which are not so essentially concerned in the maintenance of life (§ 153). The sensorial functions are only impaired, not completely suspended, for a proof of their partial continuance during sleep is to be found, not only in dreaming, but also in the voluntary movements, often performed to remove uncomfortable sensations, and even in the act of awaking when such sensations attain a certain degree of intensity.

The approach of sleep is announced by the feeling of drowsiness, which consists of a dulness of sensation, perception, and thought, and an indisposition to exertion. Gaping and yawning, although symptoms of sleepiness, result from efforts to resist it; they seem to be movements designed to throw certain muscles, especially in the throat and neck, into a state of tension, during which the sensation of drowsiness is for the moment increased to a degree rather agreeable than otherwise, but followed by its diminution. It is very probable that these movements tend to re-excite the slackening cerebral circulation by momentarily impeding it, and then allowing it to flow again with augmented force; a process like that of *flushing*. Sleep closes the relations of the senses to all moderate impressions of the external world, and suspends almost all voluntary movements, among which are to be reckoned those supplementary to the process of respiration (§ 628). The respiration is therefore rendered less frequent and more prolonged than when awake, and the pulse is also lowered. The circulation and changes of the blood being thus reduced during sleep, there is less power of maintaining animal heat; hence the chilliness of persons during and after sleep, and their susceptibility to cold, unless better protected than usual by clothing. Hence, too, the relaxation of the skin after slight febrile excitement, which during sleep yields to perspiration.

671. The circumstances which promote sleep are chiefly those which

impair the activity of the animal functions, and those which withdraw all causes of excitement to mind or body. A moderate degree of bodily and mental fatigue; the absence of all uneasy sensations; a comfortable posture, giving the most complete rest to the limbs and voluntary muscles; a freedom from the feeling of either hunger, thirst, or repletion, cold or heat; the periodic recurrence of a regular hour for repose, and the stillness and darkness of night—are favorable for the induction of sleep. In addition to these, which act negatively by excluding excitement, there are others which are sometimes found to promote sleep by causing gentle and monotonous sensations or ideas which have the effect of lulling into somnolence; such, for example, as the various expedients for hushing infants to rest, by rocking, patting the back, singing, &c., and with adults, like soothing devices sometimes succeed; as by gentle friction, reading, prosy talking, and other dull impressions on the senses which slightly tire without excitement. These probably operate by diverting the attention from other feelings or noises, which occurring occasionally, tend to disturb. The passes of mesmerism seem to act on the same principle. The expedient of counting or reciting one's self to sleep owes its efficacy (which is but small) to the abstraction of all attention to an uninteresting object.

672. The influences which prevent or disturb sleep are for the most part the reverse of those last described. Any undue excitement or sensation of body or mind, whether of a painful or a pleasurable nature; strong, sudden, or startling impressions on the senses; uneasy postures; extreme fatigue or exhaustion; oppressed or imperfect breathing; palpitation of the heart; hunger, thirst, nausea, flatulence, and various other (often undefinable) sensations in the viscera; extremes of temperature; coldness of the extremities; irregularity in habits of getting rest;—comprise the ordinary causes of sleeplessness. They operate either by directly exciting the sensorium to a degree inconsistent with the suspension of its functions, or by so much reducing or disordering the power of the medulla, that it is incapable of sustaining the respiratory movements without the aid of voluntary effort. In the former case positive pain, uneasy sensation, or exciting trains of thought, are present. In the latter there may be the desire to sleep, but no sooner does its commencement suspend the voluntary efforts by which the breathing is aided, than this process becomes imperfect, and the person starts with a feeling of oppression or impending suffocation, which his commencing dream impersonates into nightmare, or connects with the idea of being pursued by demons, falling down a precipice, or some such horrible catastrophe which entirely precludes the reality of sleep. Such are the sleepless hallucinations of delirium tremens and similar disorders, in which continued excitement of the nervous system has exhausted the energy that is required in the medulla for the maintenance of respiration and muscular tone during sleep.

673. The loss of rest is so seriously detrimental to health, that to prevent it by hygienic means is of great importance; and besides avoiding so far as possible the several causes of wakefulness just specified, bad sleepers should take heed to attend to the following directions for

their regimen, rather than resort too hastily to hypnotic drugs, which, although sometimes useful and necessary as temporary expedients, lose their effect by habitual use, and produce other evil consequences which render their continuance improper.

Bad sleepers should make a regular practice of early rising; it may cost them some trial of strength at first; but if they would improve their sleep, they should seek it at the natural time, and not late in the morning when the excitements of the day begin. Their hours of meals and exercise should also be early and most regular (§§ 644, 662); both in order to promote that state of health most conducive to ease and freedom from suffering, and also to secure the accomplishment of the processes of digestion and consequent excretion or eructation before night, which is the proper period for repose (§§ 643, 4). Exercise should be used as freely in the open air as the strength will permit without causing lasting fatigue; and if the strength do not bear walking or riding, driving or sitting out in the open air several hours in the day is an efficient means of promoting sleep by gradually and gently fatiguing the senses by the continued operation of light, air, and sound, whilst the organic energies are refreshed and invigorated by their salutary influence (§ 652). As the hour of retirement for rest approaches, every description of exciting agency should be avoided. The latest meal should be taken at least an hour before bedtime, and tea, coffee and all vegetable matters apt to generate gas should be excluded from it. Weak persons and others under the influence of fatigue may often advantageously take a little wine or alcoholic mixture at this meal; its operation, which counteracts the exhaustion and nervous excitement induced by weakness, being composing and hypnotic (§§ 64, 155). All active exertion of body or mind should be carefully avoided at this time. Subjects of conversation or reading should be commonplace or tranquillizing, neither requiring much attention nor exciting to the feelings or imagination. The very preparation of undressing should be simplified as much as possible, and all superfluous items or general washing, &c., should be postponed until the following morning. Much might be said about the construction of the bed and its appendages, and the posture best suited for tranquil repose; but this is not the place for such details, which may be comprised in the general direction that all is to be made as comfortable as possible, without relaxing by excessive softness or abundance of covering. A soft upper mattress of hair, or wool and hair, is always preferable to a feather-bed, not only in being less relaxing, but also in its giving a more elastic and even support to the body and limbs, and preventing that sinking in of the body which fatigues a weak back by bending it. The posture most easy for the person is on the right side, which affords to the two weightier organs, the liver and heart, support which prevents them from pressing on the hollower viscera. The various expedients for inducing sleep by repeating lines of poetry, counting, and numbers, and other means which act by diverting attention from exciting trains of thought, seldom succeed with the really wakeful. The plan devised by the late Mr. Gardner, and published by Dr. Binns in his *Anatomy of Sleep* (p. 391), has not proved more successful in my experience. It is founded on

the same principle of abstracting the attention, by directing the mind to the imaginary vision of the breath issuing from the mouth during expiration. A device which I have found to answer better, is founded on the attempt to imitate the mode of breathing of a person during sleep, by making the respirations, particularly the expirations, lower and more prolonged than usual, and giving to them somewhat of a sonorous character from the relaxed and therefore imperfectly open state of the glottis. This often excites a feeling of drowsiness, probably by gently retarding the return of blood from the brain; and this drowsiness may soon end in sleep; but it frequently happens with this, as with all other voluntary attempts to procure sleep, that the continuance of the effort breaks the spell by the awakening effect of excited attention, and this objection especially applies to the first attempts to practise such invocations of Morpheus. The expedient recommended by Dr. Franklin to restore sleep that has been broken, by rising and shaking the bed, with the view to change its air, is sometimes successful, particularly in hot weather.

674. The amount of sleep most conducive to health varies considerably with age, sex, employment, and constitutional and habitual peculiarities. Infants pass the greater part of the day as well as the night in sleep; and children, up to the age of six years, generally require at least twelve hours of repose, besides an hour or more in the middle of the day. At about this age, the sleep at noon may be discontinued, but the night sleep can hardly be abridged with advantage, until about the tenth year, and then only to a moderate extent, until the period of puberty, after which it is generally proper gradually to reduce the period of rest to nine or ten hours; and no farther diminution is expedient until the cessation of growth, when an another hour or two may be taken from it. The average amount of daily sleep beneficial in adult and middle ages may be stated at eight hours. In more advanced life this extent of sleep is not less serviceable where it can be procured; but at this period the capacity for sleep usually diminishes, and wakefulness or disturbed sleep is a common complaint of old age. Attention to the precautions before recommended (§ 673) will, however, often restore it; and even if they do not sleep, aged persons require an increased period of time in bed, for the sake of warmth and rest, which their reduced calorific and muscular powers render more necessary.

Females commonly stand in need of more sleep than males, and during pregnancy and lactation additional rest is especially demanded, to assist the supplementary nutritive processes brought into operation in these conditions. In such cases, too, the loss of sleep is attended and followed by peculiarly injurious results, manifest especially in the nervous system and general nutrition, in the form of mental derangement, impaired vision, deafness, paralysis, palpitation, convulsions, tremors, anorexia, wasting, diarrhœa, &c. Under these circumstances, a chief object of the treatment will be to procure sleep, and in addition to regimenal means before suggested, nervous sedatives or hypnotics of the least depressing kind are required. Persons convalescent from acute diseases, or otherwise weakened and reduced, require and generally obtain more sleep than in ordinary health, and it is so efficient an in-

fluence in the promotion of recovery, that artificial means are sometimes properly used to procure it. So, likewise, those who use much active exertion need a longer period of repose than those who are sedentary; and the same rule is applicable to persons whose minds are greatly exercised; but as mental excitement does not dispose to sleep to the same degree as bodily fatigue, it is the more important that all persons whose intellectual powers are much strained, should also use such exercise as may maintain the balance and promote the return of sleep.

675. Salutary as is the operation of sleep in its due time and degree, it may prove injurious if indulged in to excess and at improper seasons. Too much sleep slackens the circulation, diminishes excretion and muscular nutrition, and causes general plethora or partial congestions, and in those disposed, promotes the accumulation of fat. By inactivity it weakens the muscular and sensorial powers, and gives an ascendency to the medullary function; hence a tendency to spasmodic and other nervous disorders of the system, which may farther declare themselves in fits of hysteria or even epilepsy. In persons liable to this class of disorders, a judicious abridgment of sleep is often very beneficial; and it is best effected by gradually establishing the habit of early rising. Undoubtedly the most fitting time for sleep is the night, and although in these latitudes the nights are in summer too short, and in winter too long for the amount of needful repose, yet the more nearly this is assigned to the period when darkness and silence warn to rest, the better for the permanent comfort and well-being of the body. On the score of health, then, it is recommended that even adults should retire to rest, in summer especially, as many hours before midnight as can be spared after night closes; in order that they may be enabled to rise at or as soon after sunrise as they have had their proper complement of sleep. But, inasmuch as the usages of society and the business of life often make unavoidable demands on the night hours of many persons, the compromise of retiring one hour before midnight should be enjoined for the sake of health, and accompanied with an exhortation to early rising, enforced by a description of the refreshing and invigorating influences of the morning air, with all its exhilarating concomitants of light and sounds.

EXCRETION.

676. The absolute necessity of a sufficiency in the processes of excretion for the maintenance of health, has been made apparent by the numerous instances cited in the preceding pages, in which their failure has led to the production of disease (§§ 68, 248–254, 385, &c.); and although such instances commonly constitute such cases of disease as require the application of medicinal means, yet the regularity and completion of the processes of elimination may be so far promoted by common regimenal measures as to deserve a place among hygienic elements. Depending, as excretion does, on the activity of the processes—of circulation, which regulates the supply of blood to the secreting organs; of respiration, which improves the properties of that blood by renewing

its chief chemical agent, and of assimilation, which adds to its materials; of muscular contraction, which effects the expulsion of the excrementitious matter; and of sensation, which takes cognizance of the need of its evacuation—it might be anticipated that the proper performance of this office (excretion) will much depend on the vigorous condition of these several processes, which with it compose the sum of the general health. Hence many of the hygienic measures that have been recommended as contributing to sustain these several processes, are likewise efficient in promoting that of excretion. Thus a proper regulation of *food*, solid and liquid (§§ 642–644), and a regular use of *exercise* (§§ 660–662), are important means of favoring all the excretions; and the functions of the skin and kidneys, and, in less degree, those of the liver and intestines also, are influenced by *clothing*, *temperature*, *air*, and *sleep* (§§ 646–649, 652–655).

It will be sufficient to indicate a few of the more available means which are found useful in regulating the actions of the *bowels*, *kidneys*, and *skin* in health.

677. No circumstance tends more to promote the regular action of the *intestines*, than the punctual habit of daily devoting a fixed and sufficient time to their evacuation. Medical writers have long insisted on the importance of punctuality in attention to this office; but they have not recognized the necessity of dedicating an amount of time sufficient for its proper completion, yet with persons of costive habit this is not a secondary consideration. In persons whose bowels act readily, an efficient peristaltic action forwards the feculent matter in consistence and quantity fitted for prompt and easy expulsion at the accustomed time; but with those of torpid bowels (and they constitute a very numerous class, even among healthy persons), the excrement is more solid and the intestinal movement more tardy, and instead of being all in the rectum ready for delivery at the appointed hour, more or less of it may be still lagging behind in the sigmoid flexure, or above it, and cannot be discharged by a momentary effort. Nor will violent straining (which is, moreover, injurious in other respects (§§ 64, 289), properly aid in the process. Repeated gentle and sustained abdominal contractions, aided, if necessary, by kneading pressure or friction downwards in the left iliac region, in the direction of the sigmoid flexure, with some variation in the position of the trunk, are the safest and most efficient means of accomplishing this object, but they require the sacrifice of a few minutes of time; and if the end were not worth this sacrifice, I would not shock the delicacy of my readers by allusion to so disgusting a subject. These expedients are more easy and natural, and less injurious than the use of enemata; of which even the simplest kinds, if employed habitually, injure the tone of the bowel, and impair its natural action.

678. Other means may be mentioned as serviceable in ordinary health to promote a regular and sufficient action of the bowels, such as the use of brown or rye bread, instead of white; taking at night oatmeal porridge; ervalenta or lentils; white mustard seed; stewed prunes; tamarinds; baked apples, and the like; all of which act by adding either a mechanical or chemical irritant to the feculent mass, and may prove

objectionable by irritating too much and otherwise disordering the alimentary canal. The same objection applies to the addition of toasted bacon to breakfast, and that of a quantity of fruit to dinner. A more harmless, and sometimes more efficacious expedient, is that of drinking a large draught of cold spring-water at first rising, which is useful for other purposes likewise. With some persons malt liquors promote the action of the bowels. A walk before breakfast for the more robust, or a walk or ride immediately after that meal for others, often contributes to the same end; and in some instances such exertions as particularly bring into action the abdominal and other muscles of the trunk, such as digging, or other occupations in gardening, prove more effectual.

679. Lastly, we must not omit mention of the habitual use of gentle aperient medicines, as the safest and most efficacious means of securing an adequate intestinal action in persons whose sedentary occupations or other circumstances absolutely prevent their adopting more strictly hygienic measures for the accomplishment of the same purpose. Undoubtedly, it is preferable to avoid the constant use of medicine, if dietetic or regimenal management can be so conducted as to supersede it; but much observation has convinced me that this cannot always be effected, and then as a prophylactic or hygienic resource, a little daily pill is preferable to the practice of loading the stomach with indigestible matter with the object of stimulating the lower bowel. The drugs which commonly answer best as habitual laxatives, are rhubarb and aloes, both of which in their bitter properties combine somewhat of a tonic with their aperient action. Aloes is the most efficacious aperient, and if properly managed, does not lose its effects, even after many years of daily use. I know of an instance in which it was continued for fifty-seven years with unquestionably beneficial results, and the individual, in spite of very sedentary habits, retained uncommon vigor of body and mind until within a year of his death, which occurred at the age of eighty-seven. By far the best mode of administering aloes as an habitual aperient, is in combination with a little mastic, and made into a mass with alcohol, which renders the pill less soluble in the stomach, and, therefore, more capable of acting on the lower part of the canal. The combination which I commonly use, consists of three parts of socotrine aloes, with one of mastic powder, made into a mass with alcohol; two or three grains of this are to be taken at dinner or at bedtime daily. This pill has no tendency to excite hemorrhoids, provided an occasional dose of blue pill be taken to promote a sufficient action of the liver. In several instances I have found it operate more comfortably on joining with it a few grains of inspissated ox-gall. In weakly persons, a grain of sulphate of iron or quinia may be added with advantage.

680. The excretion of *urine* is less generally an object of solicitude than that of alvine function, yet it is remarkable how usually persons as they advance in years have their attention drawn to it, often from experiencing the discomforts of its regularity or deficiency; and such irregularities are undoubtedly an important element in a vast propor-

tion of diseases, whether serious or trivial. It would occupy too much time to advert at length to disordered excretion of urine here; in fact, the subject has been considered in almost every part of the present work; and it must suffice to mention a few common hygienic influences by which the urinary excretion may be promoted or rendered more free.

The abundance of urine, and therefore usually its clearness and moderate specific gravity, will be generally proportioned to the amount of fluid ingesta; but the increase is more sure, when fluid, especially water, pure, or with a very slight addition of vegetable or animal nutriment, is taken on an empty stomach. Thus, a large draught of spring-water drunk at first waking in the morning, or an hour before dinner, is almost surely followed by a free flow of clear urine. This result is promoted by such moderate exercise as excites the heart's action without causing free perspiration. Some kinds of exercise peculiarly augment the secretion of the kidneys; especially those bringing the loins into action, as gardening, and trotting on horseback; and these modes of exercise may therefore be recommended to those whose secretion is defective, especially those liable to lithuria; for by increasing the watery constituent of the urine, there is less risk of any deposit taking place in the urinary apparatus. But similar means, if regularly used, are useful also in gouty and rheumatic habits; and they appear to establish an increased elimination of solid matter, as well as of water, by the kidneys; and in this respect their operation differs from that of medicinal diuretics, which, unless very judiciously administered, excite for the time, and leave the secreting power exhausted afterwards. This is the chief objection also to certain diuretic beverages in common use, but as temporary expedients they are useful; such as gin, Hollands, or whiskey, diluted with water; spruce beer; imperial drink (water saturated with bitartrate of potass, sweetened and flavored), leek or onion-broth, barley-water, linseed, and tamarind-tea, Seltzer water, &c. Grapes, currants, and other ripe subacid fruits, also may be occasionally useful in the same way.

681. The regular evacuation of the bladder, when distended to a certain degree, is prompted by the sensation excited, but in very various degrees, in different individuals; some, either not feeling, or resisting the want, and others yielding too frequently to its impulses. The latter extreme is inconvenient, especially from its disturbing sleep at night; but the habit of too long retaining the urine may prove pernicious in various ways formerly specified (§ 68), and should therefore be carefully avoided. In circumstances interfering with a proper observance of this caution, its urgency may be diminished by limiting the amount of liquids taken, and by promoting the cutaneous excretion by warm clothing and external warmth.

682. The full purposes of the *perspiratory* secretion are not entirely known; but its uses are recognized—in evacuating from the superficial vessels superfluous water, acid, and oily matter, under the distending or exciting influence of prolonged heat or exertion; intending by its evaporation to cool the surface thus heated, and by its relaxing effect

on the tissues to remove the iritation of distension or obstruction; and by the same softening operation to render the skin more pervious to the chemical action of the air on the blood and to the vital influences reciprocated between the blood and the tissues.

The excretion of the *skin* has been mentioned to be materially influenced by *clothing*, *exercise*, and *temperature* and *air*, and these are the chief means by which it is variously affected in healthy persons.

Other hygienic measures for promoting the action of the skin, are bathing, washing, and friction. The chief operation of all these agents is on the skin, as an instrument of circulation and secretion; and in proportion as they are extensively applied, they may exercise an influençe on the whole system. Thus warm bathing of the whole body, as it increases the amount and motion of blood in the cutaneous vessels, and the perspiration from them diminishes the supply to internal organs, and consequently the amount of their secretions. If continued long, or repeated frequently, general weakness will result, the surface remaining in a relaxed state. The same objection does not apply to the occasional use of the warm bath, or the daily practice of washing the whole surface with tepid sponging or shower-bath, followed by friction; and these are highly salutary means of keeping the skin in a free and active condition well suited to persons of languid circulation. But in the majority of healthy subjects, this object is better obtained by cold washing, and in the robust, even by cold bathing, in shower or plunge, which indirectly excites the functions of the skin by constricting its vessels, and thus throwing the blood on internal organs, and by impression on the incident nerves, causes the excitement of reaction, which soon restores the superficial circulation in redoubled force, with its concomitant redness and glow (§ 80). This reaction is much promoted by vigorous friction of the whole surface with coarse towels or horse-hair gloves, and this operates not only by stimulating the cutaneous vessels and glands, but also by the muscular exertion exciting the heart to stronger and more frequent contractions; for the same reason, other exercise, as in a brisk walk, is often useful. If, after cold bathing, the reaction is incomplete, and the skin remains pallid, chilly, and contracted, it may be inferred that the cold has been too long applied, and has permanently impaired the functions of the skin, and left the internal organs more or less congested. Or, if, after complete reaction, an unpleasant fatigue, languor, chilliness, headache, or other uncomfortable sensation remain, it is a proof that the cold and subsequent reaction have been too depressing or exhausting; in either of these cases tepid bathing or washing is to be preferred. The vapor-bath, with shampooing and various aromatic and stimulant applications, although a powerful remedial agent in cases of disease (especially chronic rheumatism and its consequences), is too exciting and exhausting to be recommended as a means of preserving health.

[683. A few general rules on the hygienics of sick persons will not inappropriately close this chapter.

Patients laboring under acute disorders should be placed in large, dry, and well-ventilated apartments. The temperature of the room

should be equable and moderate; the amount of light must be regulated by the character of the disease. When the air is contaminated by noisome exhalations, fumigations may sometimes be advantageously resorted to. If the room in which the patient is taken ill be small, badly ventilated, or damp, he should be removed, if possible, into a larger one, free from these inconveniences, as the risks of moving, even in severe febrile affections, are less than is usually imagined (Chomel).

684. Great cleanliness should be strictly maintained, and for this purpose the linen should be frequently changed; but not so as to fatigue the patient. It may be done even whilst the patient is sweating copiously, and great comfort will result. To effect this, warm cloths, passed underneath the shirt, should envelop successively the legs, thighs, abdomen, chest, and even the neck, so that the arms alone will be momentarily exposed to the air. Patients should never be permitted to sleep on featherbeds, without an intervening mattress. It is often necessary to employ auxiliary means to receive the excretions, impermeable cloths to protect the bed linen, and cushions to obviate pressure on certain parts of the body. The position of the bed should vary according to the nature of the disease.

685. The employment of suitable aliments and drinks in acute affections is of great importance, and adds materially to the comfort of the patient. There are two extremes to be equally avoided: nourishing patients too much, and not nourishing them enough. Hippocrates thought it safer to err on the side of excess, than for patients to observe total abstinence. In acute febrile affections, you should observe a just medium. Proscribe all kinds of solid aliment, but permit the use of fluids slightly nutritious, such as farinaceous articles, light broths of veal and chicken, the juicy fruits, etc., when the febrile movement is not too high. In the low forms of fever, when the strength has to be supported, it is indispensable to nourish the patient, and severe adynamic symptoms may often be prevented by timely nourishment. The injudicious use of food has the power, it has been remarked by a celebrated authority, of nourishing the disease, and not the patient.

686. It is of immense importance in all acute disorders that the excretions of the patient should be immediately removed. Perspiration chills the body; the urine and fecal matter, already compromised, are disposed to speedy decomposition, and impart noxious qualities to the air. When involuntarily excreted, their contact with the body is positively injurious, by provoking eruptions, excretions, and even sloughing.

687. In acute diseases, repose and quiet are indispensable. Sydenham thought that fever patients should be made to rise every day, and that doing so obviated the tendency to delirium. There is no doubt but that patients should be daily placed in an arm-chair, or on a bed, according to their strength, in order to allow their own bed to be made; if this cannot be done, they can be removed to another portion of their bed, whilst the necessary change is made. When a patient is too feeble to change his position in bed, it should be done for him frequently; it adds materially to his comfort, prevents the formation of

sloughs, and obviates the tendency to pulmonary congestion, so frequent in protracted fevers.

688. Sleep is generally a favorable symptom in acute diseases. Everything which, by acting on the senses, or the *moral* of the patient, will prevent it, should be obviated. From the same motives sleep should not be broken to administer medicines, without the necessity is urgent. Sleep may sometimes be induced in convalescence, by causing the patient to rise, and readjusting his bed. Gentle friction with the fingers on some part of the body disposes to somnolency.

689. The sensations, the emotions, and intellectual faculties, all demand, in a special manner, the attention of the physician. The removal of all moral or mental circumstances, which either have produced or keep up the morbid condition, is important. Conversation should be banished from the sick chamber; when low, it is annoying; when loud, fatiguing and exciting. The influence of the passions of the mind is so great that nothing should be neglected to give them a favorable turn. To this end the physician should obtain and deserve the confidence of the patient, (careful attention and great interest will frequently accomplish this), and he should be careful that nothing in his manner or speech should betray anxiety or uneasiness. Patients generally receive with satisfaction assurances of the successful termination of their complaint from their physician. The fear of death adds materially to the danger, in a majority of instances, and "the physician," says Chomel, "who allows his patient to suspect the danger of his position, diminishes his prospects of recovery." Sir H. Halford, in some judicious remarks on the duty of a physician, in withholding from, or communicating to, a patient the probable issue of a disease displaying mortal symptoms, says, "that the first duty of a physician is to protract the life of a patient by all practical means."* The probability of a fatal issue should, therefore, be communicated to the friends, and, except under very peculiar circumstances, never to the patient.

690. In chronic diseases, hygienics are of immense utility. Change of habitation and climate, voyages by land and sea, a sojourn at some fashionable watering-place, &c., often succeed in restoring health when all other remedial measures have failed.—C.]

[1] Lond. Med. Gaz. vol. vii. p. 602.

APPENDIX.

THE PATHOLOGY OF GOUT AND ALBUMINURIA.

In addition to the facts mentioned in Sections 13 and 14 of Chap. II., I may state that Dr. Garrod has, in several other cases of gout, detected lithate of soda in very appreciable quantity in the blood, whilst at the commencement of a fit of gout there is a marked diminution of it in the urine. On the abatement of the attack, the lithic acid, or its compounds, appears in increased quantity in the urine, and that in the blood is therefore diminished. This exactly accords with the view that I have always taken of the nature of acute gout in common with other febrile diseases excited by a morbid matter in the blood, that the febrile excitement is the result of a reaction which may succeed in eliminating the offending matter, and in relieving the system from its influence (§§ 254, 448). It appears farther, from Dr. Garrod's analyses, that slight traces of lithic acid may be detected in the blood of persons who are comparatively healthy, or who are affected by other diseases than gout; but in this malady the amount is much greater. My clinical assistant, Mr. Edward Palmer (on whose accuracy I can fully depend), has separated crystals of lithic acid also from the blood of two of my patients suffering from degeneration of the kidneys with albuminuria. In acute rheumatism, Dr. Garrod found no increase of lithic acid in the blood; but I have little doubt, from its abundant appearance in the urine in many cases during the decline of this disease, that something analogous and easily convertible into it, does exist in the blood of rheumatic patients, and that farther researches will establish the chemical relation between two diseases which are known to border so closely on each other, in regard to their symptoms and treatment.

Some of the above-mentioned researches, and others made expressly by Mr. Palmer, have farther illustrated the pathology of albuminuria, as explained at § 385. In the case of a female, the urine voided in twenty-four hours amounted to 20 oz. sp. gr. 1018, containing albumen, measuring when coagulated three-fourths of the depth of the urine in the tube. The whole amount of solids did not exceed 372 grains of which 88 grains were albumen, and 140 urea. The patient died comatose five days after, and lithic acid, as well as abundance of urea, was found in the blood. In another case the whole amount of urea excreted

in twenty-four hours did not exceed 103 grains, whilst no less than 416 grains of albumen were passed.

The following table represents the amount of solids contained in the urine of a woman admitted into the hospital with recent anasarca and albuminuria, and treated by the remedies mentioned in § 395.

	Solids in Urine.	
Nov. 4th . .	597 grains.	—At this date the albumen half filled the tube.
5 . .	565 —	
8 . .	589 —	
9 . .	934 —	
13 . .	892 —	Anasarca now removed; and albumen disappeared from the urine.
17 . .	710 —	
18 . .	1041 —	

THE CAUSES AND TREATMENT OF SCURVY.

Except a brief allusion in § 63, little has been said in the text on the nature and treatment of *scurvy;* and this was because the subject remained involved in much obscurity, and had received little light from pathological research. A paper has been just published by my colleague and former pupil, Dr. Garrod, which propounds a view of the real cause of the disease which is at once so plausible, and so directly suggestive of a simple and effectual remedy that it deserves notice in this place. On carefully comparing the kinds of food, the use of which have been observed to be followed by the occurrence of scurvy, with the dietetic and medicinal articles which have best repute as being antiscorbutic, Dr. Garrod found the former to be remarkably deficient in potash, whilst all the latter contain it in considerable quantity. Thus, on analysis, he found oatmeal, rice, peas, white flour, cheese, and salted meat to contain much less potash than potatoes, fresh meat, milk, and the juice of limes, lemons, and oranges, which are reputed to be antiscorbutic. He farther discovered in the few scorbutic patients whom he had the opportunity of seeing, a marked deficiency of potash in the blood or urine; and the treatment by a few grains of a salt of potash was followed by speedy recovery. Dr. Garrod considers that potash is essential as a normal constituent of muscular structure, and that its nutrition must fail when no longer supplied with this alkali. "Both soda and potash are constant constituents of the animal body, and it appears that they are not capable of replacing each other; for example, we always find the potash to exist in large quantities in the ash of muscle, and soda in very small quantities (Berzelius, Liebig): in the ash of blood we find the relation reversed. It appears also that the muscular system requires the presence of potash, and we should therefore expect to find that when there is a deficient supply of this base, the effect would soon be manifested in the functions of that system. This we find to be the case in scurvy; without any amount of wasting of the body, we find marked muscular debility, and this is perhaps one of the earliest symptoms of the disease." (*Monthly Jour-*

nal of Medical Science, Jan. 1848.) I may add that the fatty degeneration of the muscles (§ 545) has been observed to occur in protracted scurvy, probably from the same want of this normal constituent of muscular tissue.

Should this ingenious theory be confirmed by subsequent research, it may prove of great value in its application to practical medicine, not in the treatment of scurvy only, but in other diseases attended with muscular debility, and a disposition to passive hemorrhage. It may be remarked that, in Mr. Blake's experiments, the salts of potash in solution injected into the veins, caused a firm coagulation of the blood, whilst those of soda had a contrary effect (§ 214), *note*). The bitartrate of potash, too, is reputed to be a remedy for hemorrhage.

ON THE USE OF CHLOROFORM.

The important discovery by Dr. Simpson of the power of the vapor of chloroform, as an anodynizing agent when administered by inhalation, in the same mode as the vapor of ether, was made since the greater part of this work was printed, the subject being only briefly noticed at page 427, *note*. Extensive trials have clearly proved it to be more potent than ether in suspending sensibility during surgical operations, painful attacks of a spasmodic character, and during parturition, and in some respects to be attended and followed by less injurious effects. Its use will, therefore, probably in great measure supersede that of ether. But there is one part of its operation, which, although recommending it in some instances, might render its use hazardous in others. It seems generally to lower the pulse, and, according to my experience, often leaves considerable debility and depression of spirits after its use. In cases of much exhaustion, therefore, it would seem less eligible than ether, which has a more stimulant action; and in all cases in which its influence is required to be sustained for any length of time, great circumspection should be used in its administration, by constant attention to the state of the pulse, and by withdrawing the inhaler so soon as sensibility is sufficiently reduced to avoid pain. It appears to me that the object to be sought is freedom from pain rather than profound insensibility, and it is obvious that this result can be obtained at much less risk to respiration and circulation than that degree of narcotization which, in abolishing all the cerebral functions, encroaches also on some of those of the medulla, and may thus endanger life. The fatal case which has recently occurred in Durham,[1]

[1] Dr. Simpson has endeavored to show (*Lancet*, Feb. 12, 1848) that death was caused in this case, not by the chloroform, but by the brandy administered to restore animation, and which, there being inability to swallow, passed into the larynx, and caused asphyxia. The appearances after death were undoubtedly those of asphyxia, with fluid blood in the right cavities of the heart; whereas in animals poisoned with chloroform, the blood is found coagulated. (Dr. Bennett, *Monthly Journal of Medical Science*, Jan. 1848.) That the insensibility induced by the chloroform favored the occurrence of asphyxia, I think, however, is proved by the absence of cough on the administration of the brandy. Even in weak persons, so long as the medullary function is active, any stimulant applied to the

as well as various experiments on animals, show that death may result from the undue operation of this agent. It is only reasonable that it should take its rank with opium and other potent drugs, which are remedial or poisonous according to the doses and condition of the system in which they are exhibited.

In one respect the insensibility from chloroform or ether differs from that from opium and other powerful narcotics; the soper comes on rapidly, and ceases quite suddenly, so that the senses are regained all at once, as after a deep sleep, and the person is quite free from all drowsy feelings. Now, although this transient duration of the soper may be partly ascribed to the agent in a volatile state being easily dispersed, yet it also seems to indicate that the suspended sensorial function resembles profound sleep rather than coma, and perhaps depends on a partially interrupted circulation through the brain (§ 670).

glottis would excite violent coughing, which would expel the offending matter. Here, then, is a reason for not pouring any liquid into the mouth of a person in the state of insensibility.

THE

STUDY OF GENERAL PATHOLOGY,

THE

PROPER FOUNDATION OF PRACTICAL MEDICINE.

EXTRACTED FROM AN INTRODUCTORY LECTURE ON THE PRINCIPLES AND PRACTICE OF MEDICINE, DELIVERED AT UNIVERSITY COLLEGE, OCT. 1, 1842.

[THE following extracts from an introductory lecture were prefixed to the first edition of this work, and they are appended to the present, not only to explain the relations which the subjects of this volume bear to other departments of medical knowledge, but also to repeat to the profession a statement of what the author considers to be the true reasons why practical medicine has not fully profited by the advancement of science, a question which has recently been discussed with much ability by Drs. Forbes, Combe, and others.[1]]

State of Practical medicine, as a study, and as an art.—Favor shown to empiricism by the public.—Irksome and difficult character of the study of medicine as usually taught.—Insufficiency of empirical and nosological medicine.—Some knowledge of general pathology at length gained in practice.—Need of general pathology in the study and practice of medicine.—What is general pathology?—Its contributions from all departments of medical science, especially clinical medicine.—General pathology the proper introduction to special pathology.—Where principles fail, experience must be the sole guide.—Noble nature and objects of medicine the best encouragements to its careful study.

I must farther state another circumstance which makes me especially anxious to use my best exertions in teaching the subjects of my course.

[1] Most of these writers appear to me unduly to depreciate British medicine, which can scarcely be said to be truly represented by the class of either practitioners or publications which have led to a sweeping condemnation of the whole system, and to revolutionary demands for a "Young Physic." On these subjects I would record my entire concurrence with the sentiments expressed by my able and excellent friend Dr. Symonds, of Bristol, whose letters (*British and Foreign Medical Review*, Oct. 1846, April 1847) I particularly recommend to the attention of the reader.

It is, *the low position which this most important part of medical science still holds with the public, and even with students.* I feel this to be a matter of such moment, that, with the hope of rescuing it from such unmerited depreciation, I propose to make the chief subject of this lecture, the state of practical medicine, as a study, and as an art.

Compare the state of the practice of medicine with that of anatomy, physiology, and chemistry — the great fundamental or preparatory studies. How minute, how precise, how connected and definite, are these! Yet how loose, indefinite, uncertain, unconnected, is the practice of our art! To the public it appears altogether vague—without any acknowledged principles.

Is there any wonder, then, that quackery should triumph? that the public show their want of faith in legitimate medicine by their ready belief in any novelty that is not legitimate? Thus, one year, St. John Long's plan; another year, homœopathy; another, Morison's pills; another, the water-cure—rules the fashion. The public may show their ignorance by such credulity; but they show also the want of something plain and trustworthy in regular medicine. The public will not believe that the secret of the art is with a faculty which professes to follow experience only. The quack also can appeal to his experience; and that too, in a way more striking and convincing than those who express doubts and admit difficulties. Thus, one who cures nervous diseases can calculate his success by the numerical method. In eight thousand cases he can count only twenty failures. Another tells you of an extraordinary percentage of success in cases of deafness, in which the *most eminent practitioners had failed*, &c. Hence you will find the partisans of quackery far more zealous in the defence of their favorite notions than others are in support of the regular art. No wonder that homœopathy and the water-cure have their royal and noble advocates. Then there is a captivating simplicity in the theories of quacks. A certain high official personage pins his faith to an empiric who was formerly a gardener, and whose notion is, that all diseases proceed from buttercups. This is the theory; every man, woman, and child, eats mutton, beef, or butter, or drinks milk; every cow and sheep eats buttercups with its grass; buttercups are rank and acrid weeds; *ergo*, all diseases proceed from buttercups. How beautifully simple! How attractive, too, are the comprehensive views of the hygeist and the water-curers! They both agree in their pathology; all diseases arise from bad matter in the blood; they only differ in their mode of expelling it from the system. One purges out the peccant humor; the other washes and sweats it forth. There is something, too, very fascinating in the notions of homœopathy; *similia similibus medentur*. Who cannot fail to admire the expansive genius of Hahnemann, who discovered that the best cure for a disease is the influence which caused it?

On the other hand, the regular practitioner has nothing so plausible or so captivating to bring forward in explanation of *his* method. He either has no theory at all, and grounds his practice on experience (in which we have said he is matched by the empiric), or, if he gives a theory, it is viewed only as an opinion no better than the hypothesis

of the quack, in an art so little founded on principles as medicine. So little favour does medicine receive from the public in its pretensions to science!

How is it with the student? Surely the practice of physic must be as interesting as it is important to the student—the useful application of all his knowledge—the winding-up of the drama of his studies—the rehearsal of the great performance of his life. Surely this must be a very attractive study? Quite the contrary. I believe it has been generally considered by students as the heaviest, most repulsive, most tedious of all subjects (with, perhaps, a single exception). Without the constant appeal to the senses with which *anatomy* attracts and rivets attention; without the beautiful connections and adaptation of means to ends which make *physiology* interesting; without the simplicity and striking phenomena which give a charm to *chemistry*, the practice of medicine, as taught, is an enormous mass of dry detail; its science, mere glimpses into an unknown land; its rules, irregular tracks through a wilderness of confusion. Practical medicine is studied only from a conviction that it is useful and necessary; and not because it is easy or agreeable.

Farther, there are a great many students, certainly not the most industrious, who shirk the disagreeable duty, pleading that it is neither useful nor necessary; and that the practice of medicine is only to be learned at the bedside, with whatever aid books can supply. It would speak more in favor of this opinion, if its advocates acted up to their dogma, and proved, by their constant and diligent attendance in the wards of the hospital, that they seek there the knowledge which they profess to be unable to obtain in the lecture-room. But, so far as my observation has gone, I do not find this to be the case. It is not those that neglect the lectures, but those who most regularly attend them, that prove to be attentive students in the hospital.

But, although useful and necessary, it cannot be denied that the study of the practice of medicine, both by books and by lectures, is at first very difficult and irksome—more so than other studies. But why is it so? This is a serious matter. Let us examine a little into it. Is the fault in the imperfect state of the subject, or in the method by which it is taught? The science of practical medicine is undoubtedly very imperfect; but I think it can be shown that there is a still greater imperfection in the method by which it is taught.

As anatomy and physiology, with chemistry, are the studies preparatory to medicine, one might expect that they should be made fundamental to that of medicine; that, starting from the knowledge of the healthy body, as taught by them, the transition should be easy and intelligible to disease—first, in its lowest degrees and simplest form; then to the more compound, pronounced, and more removed from, but still comparable with, the healthy standard. Instead of this, lecturers and writers plunge at once into the mazy thickets of inflammation and fever—subjects so complicated, so changed from anything taught by previous study, that anatomy and physiology afford little help; and no wonder that the student (like many observers and reasoners on the same topics) becomes confused and bewildered in the complexity of the sub-

ject; or, if he do make out anything, it is something isolated, abstract, about fever or inflammation itself, without its natural relations to health and to other diseases.

This plan of proceeding may be compared to a person beginning the study of mechanics with the steam-engine; or to the student of chemistry commencing with organic matter.

The general result is, that where any distinct notion of disease is acquired, it is one not at all founded on previous physiological knowledge, but it is a new idea of disease as an absolute, separate thing—not a mere condition consisting of altered function and structure, but a being, the character and history of which are to be detailed like that of a plant or an animal. And when special diseases are treated of, the same individualizing process is pursued through all the jargon of the schools. Each has its nosology, classification, and definition; its predisposing, exciting, and proximate causes; its theory, *ratio symptomatum;* its diagnosis, prognosis, indications of cure, fulfilment of these, *juvantia et lædentia*, and prophylaxis!

With all this formidable array to each disease, the practice of physic was an arduous study in the days of Cullen. What must it be now, when the diseases of Cullen's nosology have been almost doubled, and the facts relating to them have been more than doubled?

But let us follow the student, well crammed with his nosological list, their definitions, &c., to the bedside. Let us see how his knowledge, so meritoriously and laboriously obtained, will serve him in the hour of need. In a few cases of fully developed and well-marked acute diseases, such as pleurisy, scarlet-fever, or rheumatism, he may get on pretty well; but in the commoner description of cases, acute or chronic, in their early stages, in their endless variations from peculiarities of constitution or from complicating causes, he finds himself continually puzzled; the phenomena do not correspond with any of his defined diseases; they frequently change their character in a way that he cannot account for; his prognosis is falsified; his diagnosis fails; and his treatment, although not always unsuccessful, does not answer according to his expectations; some patients recovering whom he expected to die; others dying, or not improving, whom he expected to recover.

Disappointed in the failure of his nosological learning, the young practitioner more and more mistrusts it, and falls into a routine of empirical practice. Without troubling his head about the name or nature of diseases, he thinks solely of their treatment; and, begrudging the time that he has spent with books and lectures, he decries everything that is not practical.

Still, he is obliged to retain some notions of the theory of disease; but they are general notions, and not fettered by definitions. He still studies symptoms; he seeks in the pulse and heat of skin indications of fever and inflammation; he looks to the tongue and alvine evacuations for proofs of disorder of the digestive organs; he judges by the complexion and muscular strength the state of the constitution. Instead of troublesome scholastic definitions, he uses convenient, general terms, which may be taken in a pretty vague sense—such as irritation, congestion, constitutional weakness, cachexia, disordered digestive or-

gans, scrofula, scorbutic habit, and the like; and his remedial measures are designated in the same convenient general terms—such as soothing, cooling, supporting, stimulating, alterative, purifying, &c.

In short, he has, in practice, learned himself, in a loose way, at the expense of previous studies, and sometimes, it is to be feared, at the expense of some bad practice, what he ought to have been properly taught as the foundation of his studies—*general pathology*. Thus we are led to the presumption that general pathology is the proper basis for practical medicine; and I venture to affirm that a chief reason why the practice of medicine has been commonly so distasteful, and so difficult in its study, and so unsatisfactory when tested at the bedside, is, because its foundation, *general pathology*, has not been efficiently taught.

We have just met with a practical illustration of the truth that general pathology is a more efficient help at the bedside than such knowledge of diseases as is to be obtained only from nosological definitions and details. Before I proceed to exemplify this truth, by matters of every-day experience, let me first briefly point out why it is so.

Without the connecting link of general pathology, practical medicine derives little or no aid from anatomy and physiology. Instead of being founded on them, it is studied and practised quite independent of a full knowledge of them, and is generally acquired in proportion as they are forgotten. This kind of practical medicine is much the same as that of old women and nurses; it consists chiefly of treating symptoms, or groups of symptoms (called diseases), by remedies that have been found useful in similar cases, without the trouble of inquiring about the causes of the symptoms, or the precise seat of the disease. Thus, if a person complains of headache and giddiness, leeches are applied, purgatives are given, because they have been found useful in similar cases. An intimate knowledge of the structure and functions of the contents of the head would give no farther help in the use of these remedies; nor suggest others, if these be found to fail. If they do fail, the only resource is in experiment; first one thing is tried, then another, until much mischief may be done, or at last, perchance, the right remedy may be hit upon; and this may be the very opposite of those first used. Long experience may make the symptom-treating practitioner more successful, if he be an observing man; because it will acquaint him with additional symptoms to be considered for the guidance of the treatment. But there are few of this class of practitioners who are carefully observing men, who do remember and profit by their experience; they more generally, like their sisters, the nurses, keep pretty close to their first notions; and although age and the name of experience may screen *their* failures, alas for the young adventurer who sets sail on this tack!

But the benefit of such experience is gained at the commencement by the student of pathology. He has learned to trace symptoms to their causes. Having been taught, by anatomy, the peculiarities of the circulation in the head—and by physiology, confirmed by clinical observation, that this circulation may be similarly impeded by opposite causes, inanition as well as fulness, he is prepared to find out, through

other symptoms, which is the cause of the headache in the case before him; and he adapts his remedies accordingly.

In fact, a true pathology, or sound principles of medicine, is the embodiment of the results of experience in disease, with a knowledge of structure and function in health. It is the only connecting link between the preparatory sciences and practical medicine. *Without* it, these are *disjecta membra; with* it, they form a connected body of science—young yet, it is true, and falling short of the objects of the art, but already available for much, and needing only the growth and continued support of its chief members, especially anatomy, physiology, and clinical observation, to become the perfect and efficient director of practical medicine.

The great proof of the practical utility of general pathology is, the aid which it gives in the study of clinical medicine, and the light which clinical medicine continually throws on it. The states which the practitioner has to treat are often too indefinite or too mixed to correspond with any of the definitions of special disease. They frequently consist of functional disorder, varying with time and circumstance, or changing its place, so as to present no fixed characters. But, compared by the pathologist with the standard of health, and analyzed from their complexity, their nature becomes intelligible, and their proper treatment obvious, so far as means are possessed to counteract or control that which is wrong. Let us take one out of many examples. The disordered state of health, for treating which Mr. Abernethy gained such a reputation, is one of the commonest ailments we have to prescribe for: some call it, with Abernethy, "all stomach;" others, "liver;" others, "disordered constitution;" others, "indigestion;" but, however differently they may name it, few refuse to treat it, as Abernethy did, by regulated diet, blue pill, and mild saline aperients, repeatedly administered. Now the pathologist analyzes the symptoms of such a state; and, in the white or yellowish furred tongue, morbid eructations, tender epigastrium, sometimes full right hypochondrium, with extended dulness on percussion, the discolored feces, the high-colored and turbid urine, he finds proof of congestion and disturbed secretion of the liver and upper part of the alimentary canal; and he recognizes in the remedies employed, means which, by increasing the secretions, relieve the congestion; and if these fail, he can suggest other measures which he knows to be efficacious in removing congestion, and restoring the natural secretions. Again, what confusion in diagnosis, as well as in practice, has arisen from comprehending, under the specific name of *hysteria*, the most opposite and most varying conditions, merely because they are consorted with some nervous phenomena; so that this word becomes almost synonymous with *female diseases*. But, pathologically considered, the confusion in diagnosis, and, in some measure, the perplexity in regard to treatment cease. In one group of such cases, the pathologist finds really such signs of disordered *uterine* function as would justify the name; other symptoms, however varied, taking their origin from this disorder; and he thus discovers the necessity of directing the treatment to this cause. In another group, again, he finds the uterine function impaired; but this only in common with other

functions; and all this in consequence of a *want of blood* throughout the body, which want is denoted by the waxy complexion, the pallid lips and gums, the loose yet easily quickened pulse, the panting breath, the feeble limbs, &c. Here the restoration of the blood is the obvious indication; and in proportion as this is effected, the symptoms of nervousness, debility, and loss of function, disappear. In a third group of cases, called hysterical, the pathologist discovers the opposite condition, that of *sanguineous plethora*, which, independently of any disorder of the uterus, causes trouble, sometimes in one part, sometimes in another, but especially in the nervous system, which, in most females, is peculiarly liable to disorder. Here, too, he is led to the most appropriate treatment.

This is but one instance out of many that might be adduced to show the great practical utility of a good knowledge of pathology. In fact, the leading rules of practice, those which guide the most experienced men (although many are not aware of it, and would not acknowledge it), *are* founded on general views of diseased function and structure—that is, *general pathology*. You will not find that practical men treat a disease merely according to its name, or according to the nature of the local mischief. Inflammation is not always to be combated by bloodletting, nor hemorrhage by styptics. The condition of the system—that is, of the functions, is to be taken into account; and the variations of this condition, the states of sthenia and asthenia, tone and debility, excitement and depression, plethora and anæmia, are the very subjects which general pathology explains and shows how to treat.

I say, practitioners *do* act more on general ideas of disease than on their knowledge of particular diseases. They feel the pulse and the skin, to guide them in the use of bloodletting, whether they have found out the special disease or not. They examine the tongue, and inquire as to the state of the evacuations, to guide them in the use of purgatives, under whatever complaint the patient labors. They consider the complexion and bodily strength in connection with dietetic measures; and the chief treatment of convalescence depends on rules suggested by general pathological knowledge.

There are other very important departments of medicine which are comprehended in general pathology, and with it have been too much neglected—I mean, the study of the causes of disease and their modes of operating on the living body (*etiology*), and the means by which they may be avoided or counteracted, including *prophylaxis*, or the prevention of disease; and *hygienics*, preservation of health. Neither of these subjects can be satisfactorily comprehended without a sufficient knowledge of the elements and laws of disease.

Is it not, therefore, most important that these general views, which are so practical and so extensive in their application, should be well founded and carefully studied? Is it right that the leading doctrines of disease, leading, not in theory but in practice, should, as hitherto, be left to be picked up irregularly, from casual retrospects of study or experience, when they may be learned as the very groundwork of practical knowledge?

What, then, is this general pathology, which we extol so much as the

proper foundation of practical medicine? Let us first state what it is not. It is not a collection of hypotheses hung on solitary facts, and ingeniously devised to explain this or that symptom, or the *modus operandi* of this or that remedy. It is not anything floating on (I cannot say, founded on) conjectural notions in anatomy and physiology, such as the existence and circulation of a nervous fluid, the presiding influence of the ganglionic system, or the vital attractions and repulsions of the circulating fluids; notions which, however they may hereafter be substantiated, are at present too speculative to form a foundation for pathology. Nor is it a partial set of opinions, erected on *one* only of the many pediments of fact on which the science of medicine should stand. Healthy anatomy, physiology, physics, chemistry, the study of clinical medicine, that of materia medica, morbid anatomy—neither of these *alone* can furnish a foundation for pathology—that foundation must be formed by ALL—the facts which all supply constitute the material of which it is built, and the general facts or laws of all must be brought to bear on the arrangement of these materials in the construction of a system of pathology.

Some advancement in these contributory departments is necessary before the work can be begun, and it is because they *have* advanced, that the opportunity is afforded. Why should the science of medicine remain in a state of powerless infancy, when its members are progressively acquiring strength and maturity? Why should the art of medicine still be groping about in blind empiricism, and an unintelligible confusion of facts, when science even now can afford it the beginnings of light and of order?

I have just said that the contributory sciences are sufficiently advanced to be generally applicable to practical medicine. The proofs of this in detail, will, I trust, appear in the progress of the course; but I will adduce here a few examples of a prominent kind. Disease, in so far as it is the result of *mechanical* change, or in part made up of mechanical elements, may be properly treated by *mechanical* means. It was the knowledge of this fact which led Dr. Arnott to invent that admirable contrivance, the water-bed, by which disease is often prevented and removed; and he has lately made another application of physical science; in modes of applying pressure to parts with such equality as to control to any degree the circulation of the blood through them, and thus to relieve pain, remove congestion, subdue inflammation, heal ulcers, disperse swellings, and arrest the growth, if not to effect the removal, of tumors and other morbid productions. Disease, so far as it is physical in its nature and in its effects, is to be investigated by physical means. Hence the advantage of acoustic science in assisting us in diagnosis of internal disease, and of optical science in enabling us to witness the minutiæ of its operations and its products. I need scarcely add, that the treatment of disease is in some instances founded on, and in most cases guided by, knowledge thus obtained.

As an example of improvements in *anatomy* and *physiology* bearing on practical medicine, I may mention the late researches on the nervous system, and especially those of Dr. Hall. By these, much that before was unintelligible in diseases of the nervous system has been

satisfactorily explained, and their diagnosis and treatment have received proportionate aid. Considerable light has been thrown on diseases of the liver and of the heart, by recent anatomical and physiological investigations of these organs.

The aids afforded by *chemistry* to the materia medica have been long acknowledged, and continue to increase; but chemistry is growing in importance in its applications to every department of practical medicine. It is now directly useful in the diagnosis and treatment of diseases of the urinary organs. It furnishes a key to the most important rules of diet, in health as well as in disease, and bids fair to supply much that is wanting in explanation of the origin of many maladies, and the most direct mode of preventing them. It is through the aid of organic chemistry, now far advanced—advanced, too, mainly by the labors and genius of an illustrious chemist, who this day honors us with his presence (Professor Liebig)—that we may hope that experimental physiologists and clinical observers will be enabled to solve some of the dark problems of the operation of medicines; a subject replete with practical importance, yet one that still lies chiefly in the region of conjecture.

It will not be disputed that *clinical observation* has lately done much for the advancement of the science of medicine; and this, not only because it is the test by which the contributions of other branches are tried, but also because in itself it is carried on with the minuteness and precision which are essential to science. This precision must apply, not only to the modes of calculating facts, but also and most particularly to the correct determination and classification of these facts. The accuracy of counting is a mere facility in common arithmetic. The accuracy of observing and arranging the facts to be counted is the higher and rarer quality. Both are required in the prosecution of clinical research.

The whole department of practical medicine teems with examples of the benefits which it has derived from *morbid anatomy.* What should we know of the nature, products, and tendencies of inflammations, and other diseases which alter the structures, but for the scalpel revealing them to our very sight and touch? The minuteness with which it (morbid anatomy) has been pursued in connection with clinical observation, in regard to diseases of the lungs, heart, liver, kidneys, and alimentary canal, deserves especially to be mentioned as the great source of our improved theory and practice in these complaints.

It is not a general or superficial knowledge of any of these fundamental sciences that will avail to make them profitable to medicine. It is where their facts and laws have been carefully studied, in relation to the living body, that the advantage has become practical; and this study has in many instances developed new phenomena, which reflect light also on the contributory science. The application of hearing to the distinction of diseases has given rise to a more intimate knowledge of acoustic science. Some of the most interesting facts and laws of organic chemistry have resulted from researches instituted with reference to the investigation of disease; as, for example, those of Prout, Wohler, and Liebig. In regard to anatomy and physiology, the instances are abundant. For example, the researches of Charles Bell,

Foville, and M. Hall, on the nervous system, and those of Astley Cooper on the testicle and mamma, were conducted with express reference to diseases of these organs, and were often suggested by the knowledge previously possessed of these diseases. In this respect they followed John Hunter, who throughout his anatomical labors had an eye to pathology, and by observing disease, was continually guided to objects for these labors.

So we shall find, as we proceed to the details of pathology, that subjects which require farther research are continually presented to us in a practicable form; and I shall take occasion to point out these as they occur, in the hope that some among you may be induced to cultivate ground which is rich in promise of important practical results.

Do not suppose, because I insist strongly on general pathology being the proper basis of practical medicine, that this will lead us to neglect the superstructure, *special pathology*. Individual diseases will be the chief subjects of the course, occupying 100 out of 150 lectures; and I trust that their details will become much more comprehensible by the arrangement into which general pathology will enable us to distribute them. It is because I feel the vast importance and extent of our knowledge of individual disease, that I would endeavor to introduce you to it from the most advantageous and commanding position; and that position is afforded by a previous acquaintance with the general features of disease. In fact, individual diseases are like the leaves and boughs of the tree, of which general pathology constitutes the trunk and great branches—all preserving an identity and connection, yet each portion having peculiarities of character which require separate study. Or medicine may be compared to a great edifice, the foundation and chief entrances of which represent pathology, which generally give the proper approach to the separate rooms, special diseases. To some of these, in the imperfect state of the structure, there may be access only by the dark back ways of blind experience, which then must not be neglected; but this is no reason for continuing to make these *dark back* ways the only entrance.

Throughout our examination of the details of disease, we shall find the principles of general pathology continually exemplified; and through these principles the mind can master the details to an extent wholly unattainable by those who pursue them as unconnected matters of fact. Those who begin the study of practical medicine by attempting to learn the details of diseases, are like those who would endeavor to master all the facts of chemistry without any knowledge of the general facts or laws of chemical action, affinity, and definite proportions; yet even in practical chemistry, or chemistry applied to the arts and manufactures, the most extensive and important services have been obtained from these very principles, applied to the details.

But in treating of individual diseases, although we shall find our previous pathological principles of great use in explaining and simplifying the details, we are not to be tied to them whensoever experience varies from those principles, or goes beyond them; then, experience must be carefully followed. There is no subject in which this simple statement of fact is more frequently necessary than in regard to the

modus operandi of medicines. It is quite true that many curious speculations have been offered on this subject. In fact, it seems to be quite the hobby, or the Pegassus, of a very speculative class of men who call themselves practical. These can tell you to a nicety how mercury cures syphilis; how opium causes sleep; on what precise parts of the intestinal tube each variety of purgative acts, &c. But, as in most of such hypotheses, there is much more of fancy than of fact; and as the fancy, if erroneous, may be mischievous in a strictly practical matter, I shall be excused if I prefer giving you the naked matters of fact.

The purpose of lectures on the practice of medicine is not merely to convey knowledge of disease and its treatment, but also to direct the mind in the ways of using this knowledge, and of acquiring more. Books will supply details which cannot be given in the lectures; but the more important additional source of information is *clinical instruction.* This is an essential part of the teaching of practical medicine. It is its demonstrative part, and is essential, not only because, like other witnessed phenomena, it appeals to the senses, but also because it is necessary to practise those senses in the examination of the signs of disease, and to exercise the reasoning powers in the interpretation of those signs, and in the farther application of previously acquired knowledge. As general pathology is the connecting link between the preparatory studies and practical medicine, so clinical instruction is the step between the knowledge of medicine and the personal application of that knowledge in actual practice. I need not say that each of these is most necessary to the formation of a good practitioner; but there are especial reasons why clinical study, connected with the practice of medicine, is more indispensable now than it ever was. In former days, medicine was little more than a matter of routine; and the examination of a patient was summed up in feeling the pulse, looking at the tongue, and asking a few questions as to the feelings and functions, and this was often done for the sake more of form than of information; for the pills and draughts were much the same in most cases. This was little better than quackery, and required no great preparatory study. That it sometimes succeeded to win the favor of the public is not surprising, seeing that quackery often had a similar or greater success. Then the ignorant practitioner could disguise his emptiness by a cloak of mystery, and a solemnity of manner, and could command confidence by dropping a hint about his experience, tact, and intuitive perception of disease. But, ignorant as people still are in medical matters, they are not so dull as to be deceived by these means. They have a smattering of physiology and the use of remedies, and they are become troublesomely inquisitive; and if they are taken in, it is by the clever quack, who is ready with his theories and persuasive proportion of cures, and not by the unsatisfactory regular, who examines but little, and cannot explain his views or his practice. In short, the public look for what they have a right to expect, thoroughly educated practitioners, who prove their qualifications by their careful method of investigating disease, the clearness with which they give their opinions, and the general correctness of those opinions.

This, then, is another reason for thoroughly availing yourselves of practical instruction, especially in the clinical department. The great importance of this department has occasioned the adoption of extended measures for teaching it. I trust that you will prove, by the assiduity and success of your practical studies, that the college has not adopted these means in vain; but that, as in the preparatory branches, so in the finishing of your medical education, you will obtain that high standard of qualification, that must insure the confidence and esteem of those among whom you may exercise your calling.

Gentlemen, we have great pleasure in meeting you again for the session—those who have favored us before, as old friends; new-comers we welcome to the work, which although arduous, is not one of drudgery. I almost envy the pleasure, in young and ardent minds, of rising step by step in knowledge, and delighting in the wonders and beauties of the enlarging view. I admit that the ascent is arduous—that it requires hard labor, and no little self-denial. But is there no compensation in the delight of acquiring knowledge and intellectual power? No gratification in learning and contemplating the intricate beauties of the most perfect part of the creation? Is there no moral and religious good to our own minds in tracing out and unveiling its frailties, weakness, decay, and death? No satisfaction in learning of means which a gracious Providence supplies for preventing and removing the ills which flesh is heir to; for relief of pain, suffering, and weakness, and restoration of health and strength? And if from present studies you carry your anticipations onwards to their final object in practice—under Heaven, yourselves to ease suffering humanity, and to invigorate and prolong life—is the pursuit less noble, or less worthy of your highest thought? Need I say more for the intellectual and moral greatness of our art?

Is a study noble in proportion to the breadth and depth, and diversity of the knowledge on which it is founded? Then, think of medicine; how she levies her contributions from every branch of knowledge. The human body exhibits a machinery so perfect, that the most skilful mechanical philosopher may take lessons from studying it. It contains a laboratory so diversified, and chemical processes so subtle, that therein the ability of the most expert chemist is far surpassed. But the knowledge of the student of medicine must go beyond that of the mechanical and chemical philosopher. He must study those vital properties of which they can tell him nothing. He must become acquainted with the attributes of life operating in matter. In animal generation, nutrition, growth, secretion, motion, and sensation; in the variations of these processes, in their decay, and in their cessation, which is death, he has a complicated study, peculiarly his own, in addition to those of a more elementary nature. He has, besides, to contemplate the body under disease, and to bring to his aid the three kingdoms of nature, and almost every art and every science, for agents and means to counteract and control that which disturbs its well-being. But is the body the only object of his care? No. Mind and matter are too closely combined to be studied or treated apart. To medicine

alone it belongs to contemplate and to treat the ENTIRE MAN—PHYSICAL, MORAL, AND INTELLECTUAL. What can I say more of the intellectual greatness of our art?

Neither shall I strain your thoughts far to remind you of its moral worth. See its effect on masses of mankind, displayed in the progress of the happy discovery of Jenner! See how even barbarous people and idolaters, Mussulmans, Hindoos, and Chinese, respect our nation only for the medical aid which it can supply. So that it has happened that medicine has become the handmaid of religion—a bond between countries, a peace-maker between nations.

But let us not vaunt ourselves. Listen to one who speaks of our art—and that one the eloquent ambassador from the United States, the Honorable Edward Everett. I quote from the *Times* of the day before yesterday: "For what was that which constituted the chief pride and glory of the British nation? They had heard of the intercepted letter from one Chinese chieftain to another; and what was the characteristic which had excited the admiration of the mandarin of a great and important empire, reeling at the time under the blows of the British government? Was it the steam-vessels of war reaching coasts in defiance of the desolating simoom? Was it their arms—their artillery—their skill of engineering, which civilized nations now brought to the strategy of war? Was it this, or any of these, which had struck with wonder, and awe, and admiration, the barbarians of China? No! It was the humanity of British physicians and surgeons—their management of hospitals, and the generous kindness which was extended to the sick and wounded, even of a hostile nation, which moved them with astonishment, and excited their sympathy and regard. These were some of the arts of peace which extorted the admiration of an enemy, and which other states would do well to imitate."

But if you would see the moral influence of medicine depicted in its liveliest hues, I would ask you to contemplate a domestic scene—a family whose hearts are wrung with a dreadful anxiety for one vibrating between life and death. What a ministering angel does the physician seem! How they watch his every look! With what breathless earnestness do they hang on his words! and those words, how they wing themselves to the souls of the hearers for sorrow or for joy! Yet such scenes are passing daily and hourly in every class of society—in the mansion and in the cottage; they open the hearts of all; for the moral influence of medicine is bound up with the treasures of life and health, and with all those endearing ties that make these treasures doubly precious. Nay, how often, with the hopes, or fears, of a blessed or an awful eternity!

Do not think me too enthusiastic, nor overrating the profession you have chosen. Morally and intellectually I cannot overrate it; and now, at the commencement of a new epoch of your studies, when toil and exertion are required, I would cheer and encourage you, by reminding and convincing you of the intrinsic gratification which these studies may afford, and of the nobleness of the objects for which they prepare you.

It is the fashion to decry our profession—to call it a poor profession, a degraded profession. If it be poor and degraded, is that the fault of the calling, or of those who practise it; or rather of those who should have governed and protected it? Is the art of healing in itself less noble, because its practitioners, unsupported by the arm of civil power, and too often unsustained by a consciousness of their own dignity, have not raised it to the place in society which it ought to hold? Poor it may be, slighted it may be, but degraded it cannot, shall not be, so long as its foundation is science, and its end the good of mankind.

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